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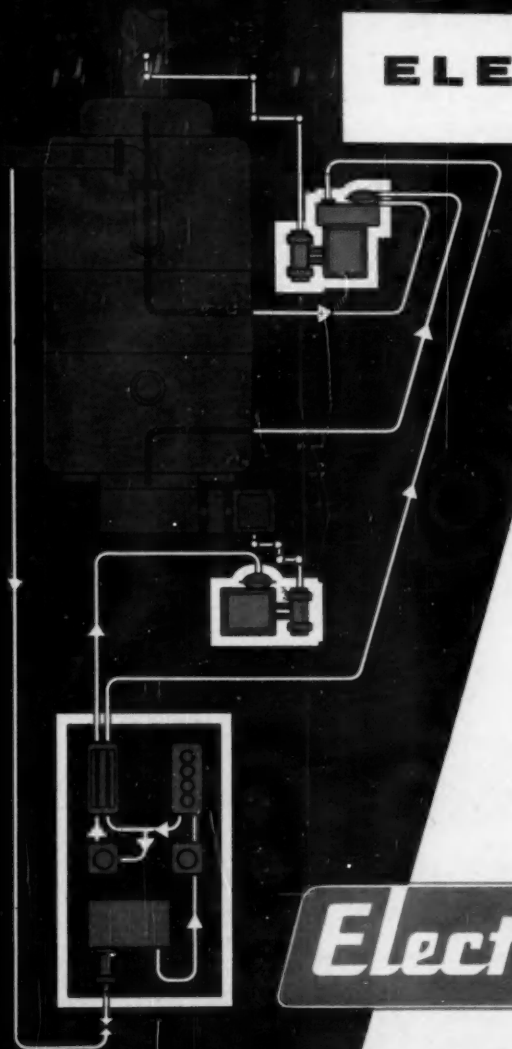
1899

VOL. 73 NO. 1 • THE PIONEER STEAM JOURNAL • JANUARY, 1958



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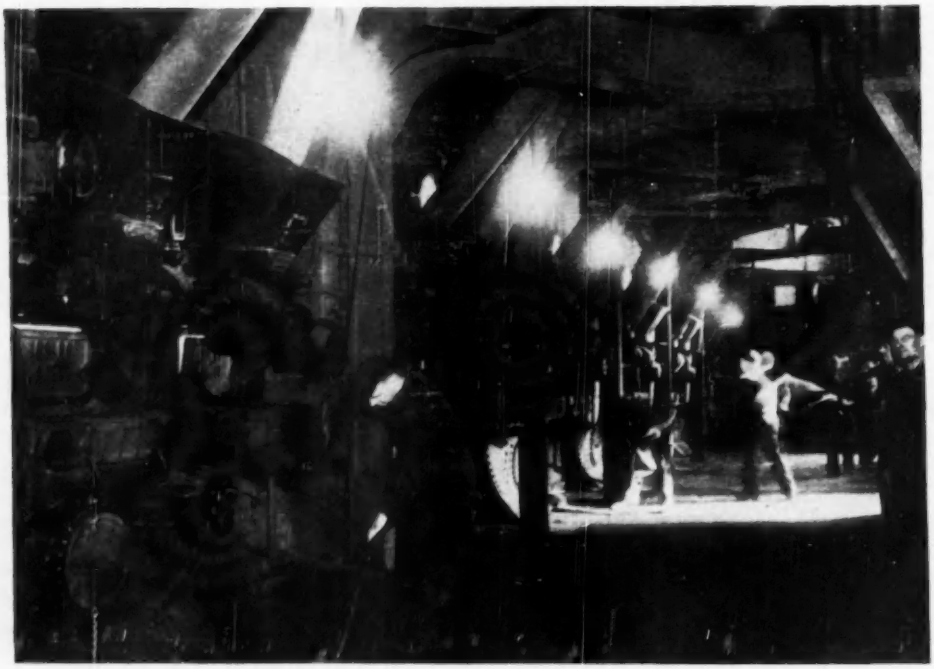

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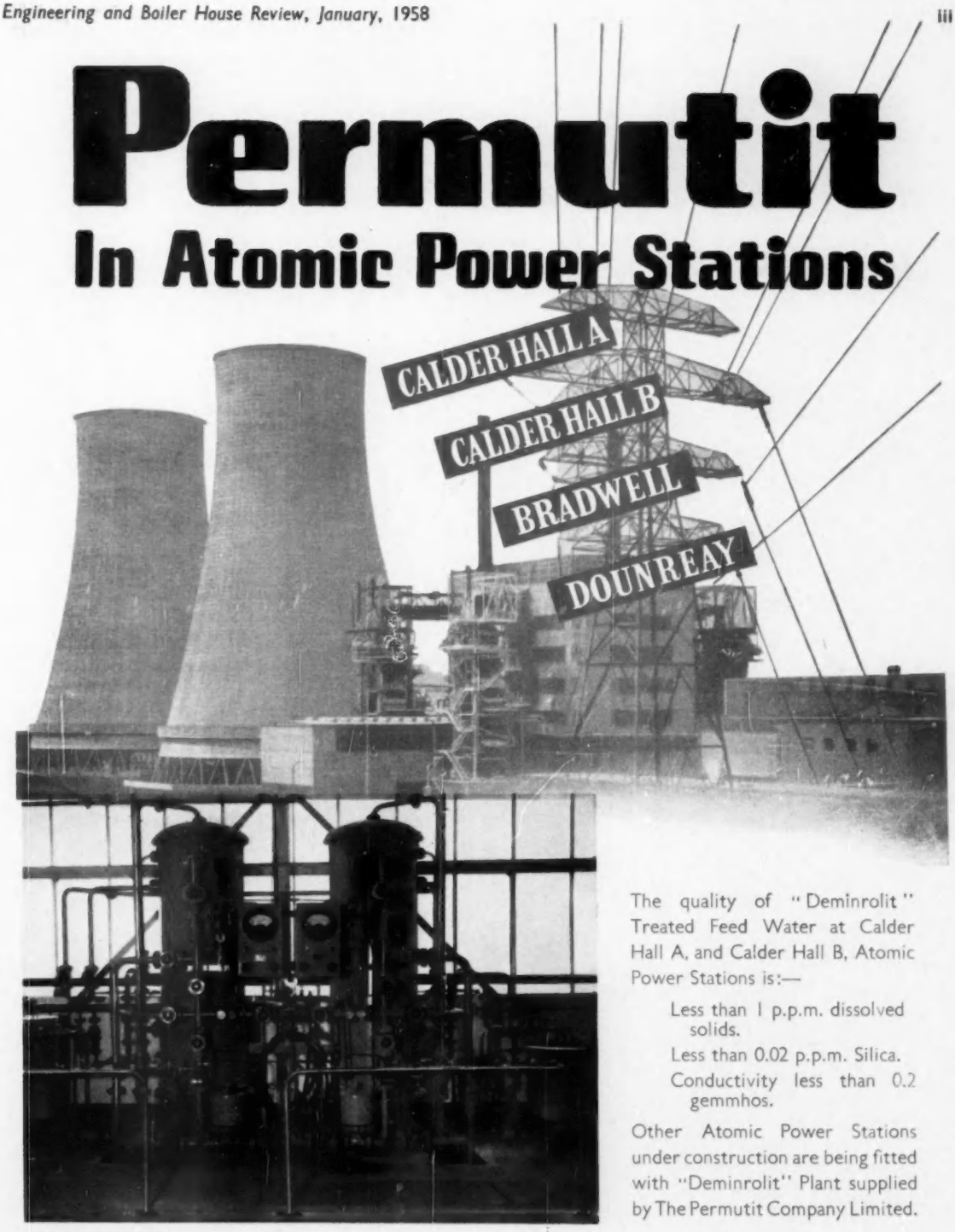

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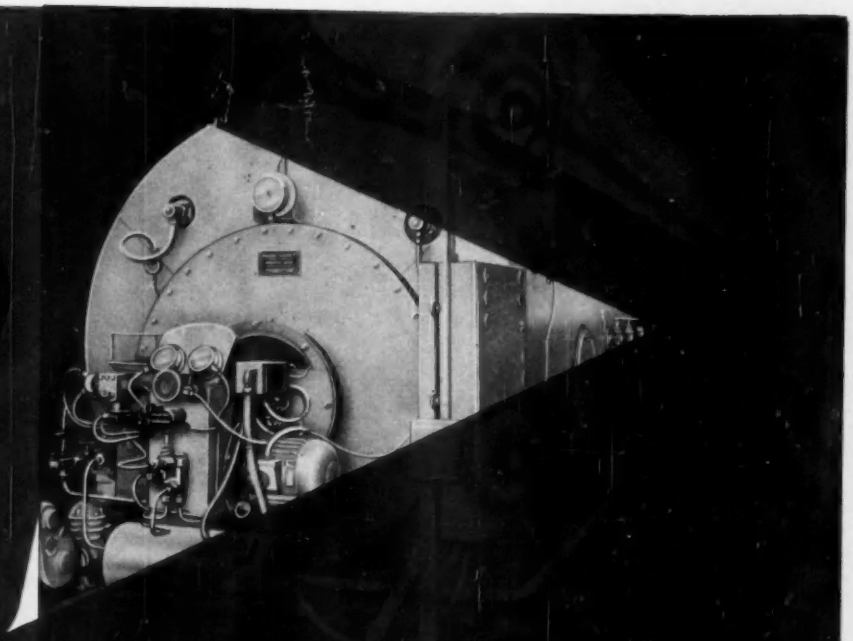

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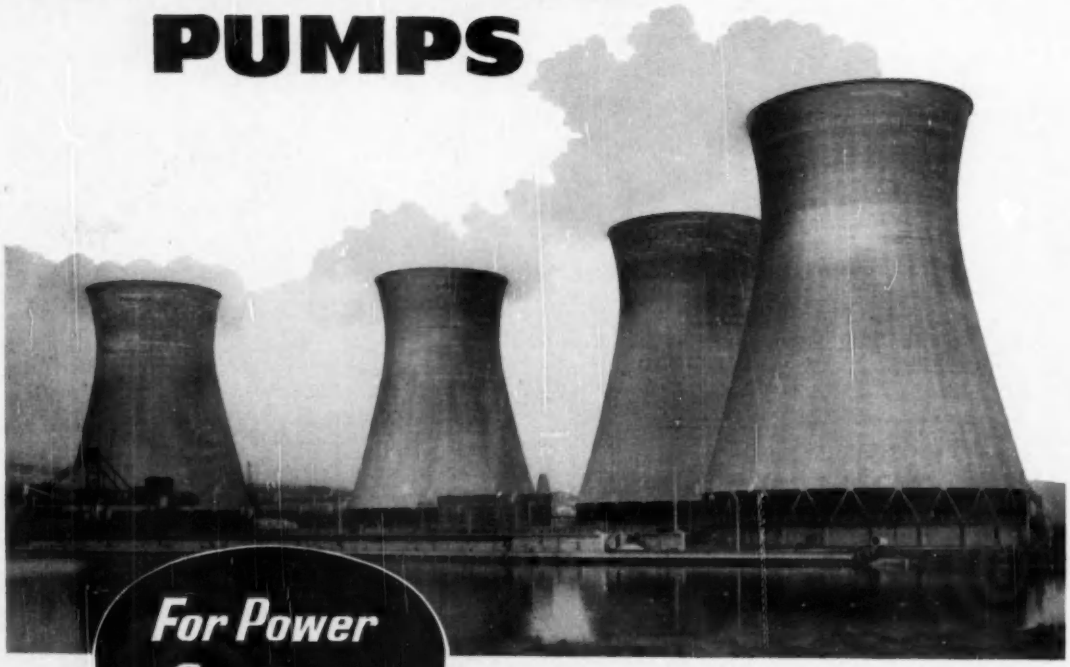

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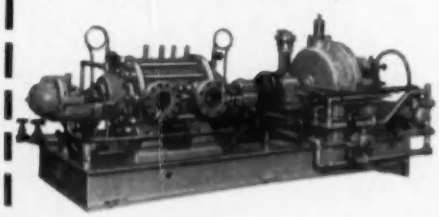

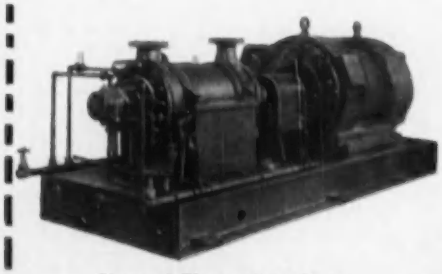

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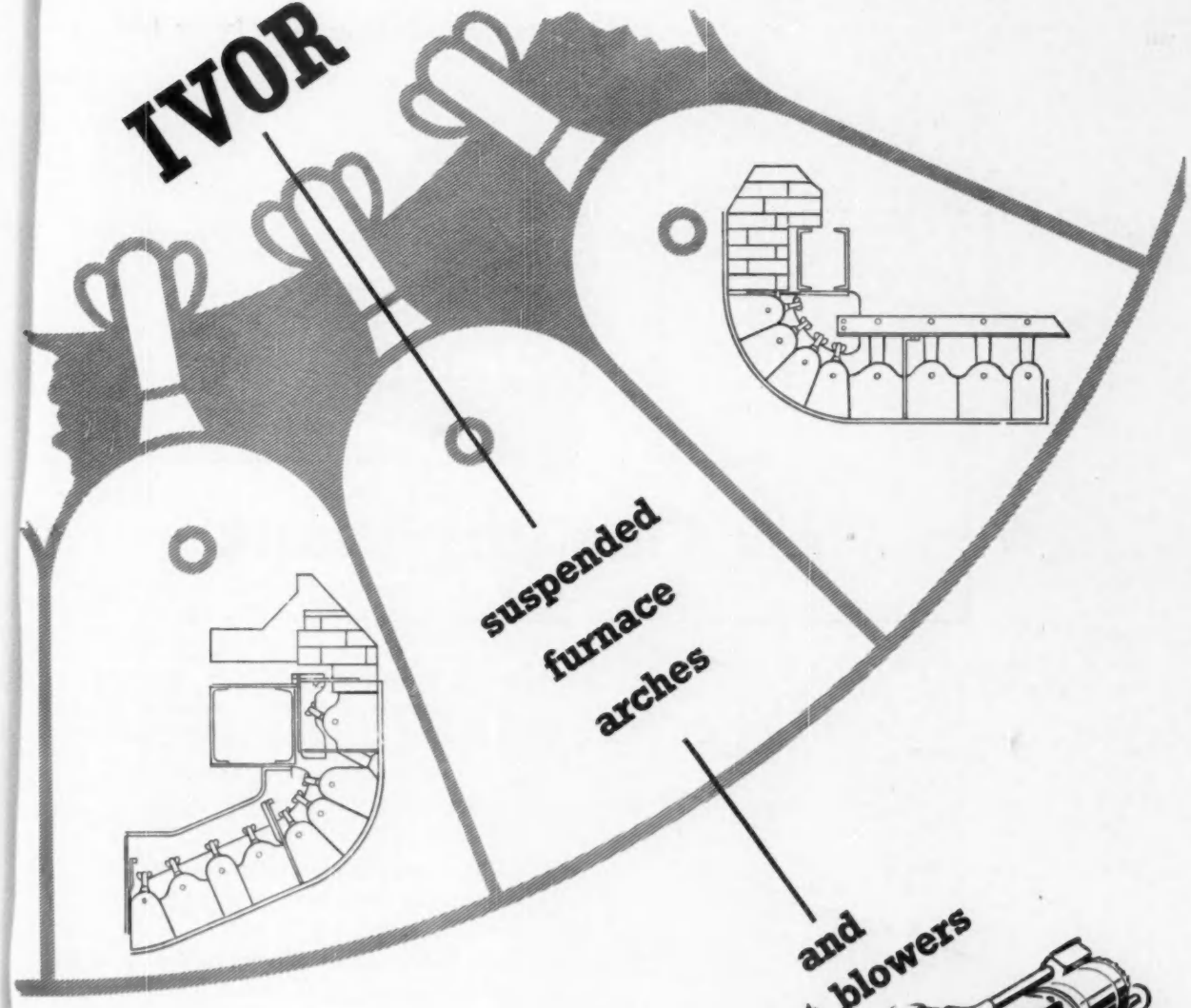

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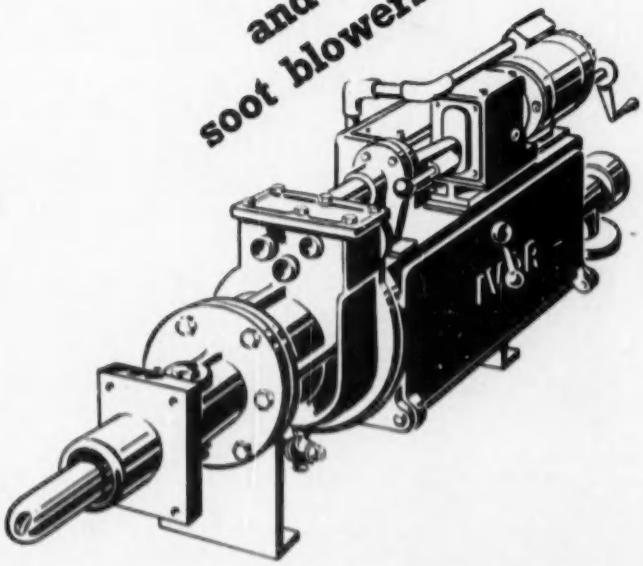

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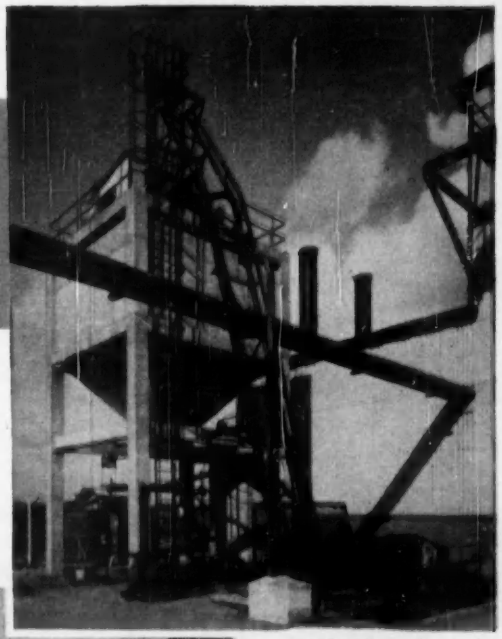

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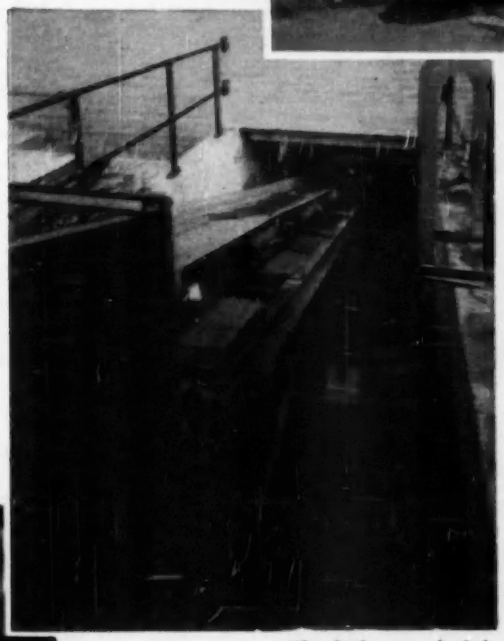
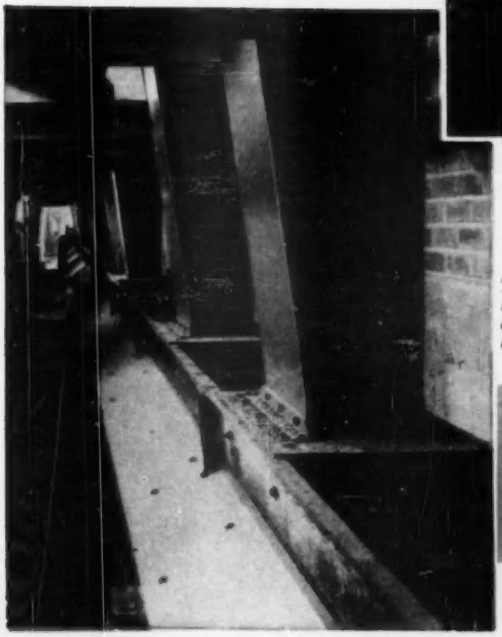


The discharge end of the submerged conveyor belt emerging from the trough.



The trough with submerged belt, showing the ash chutes from the boilers.

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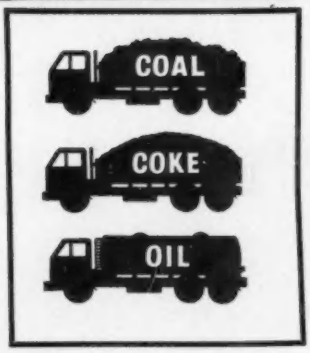

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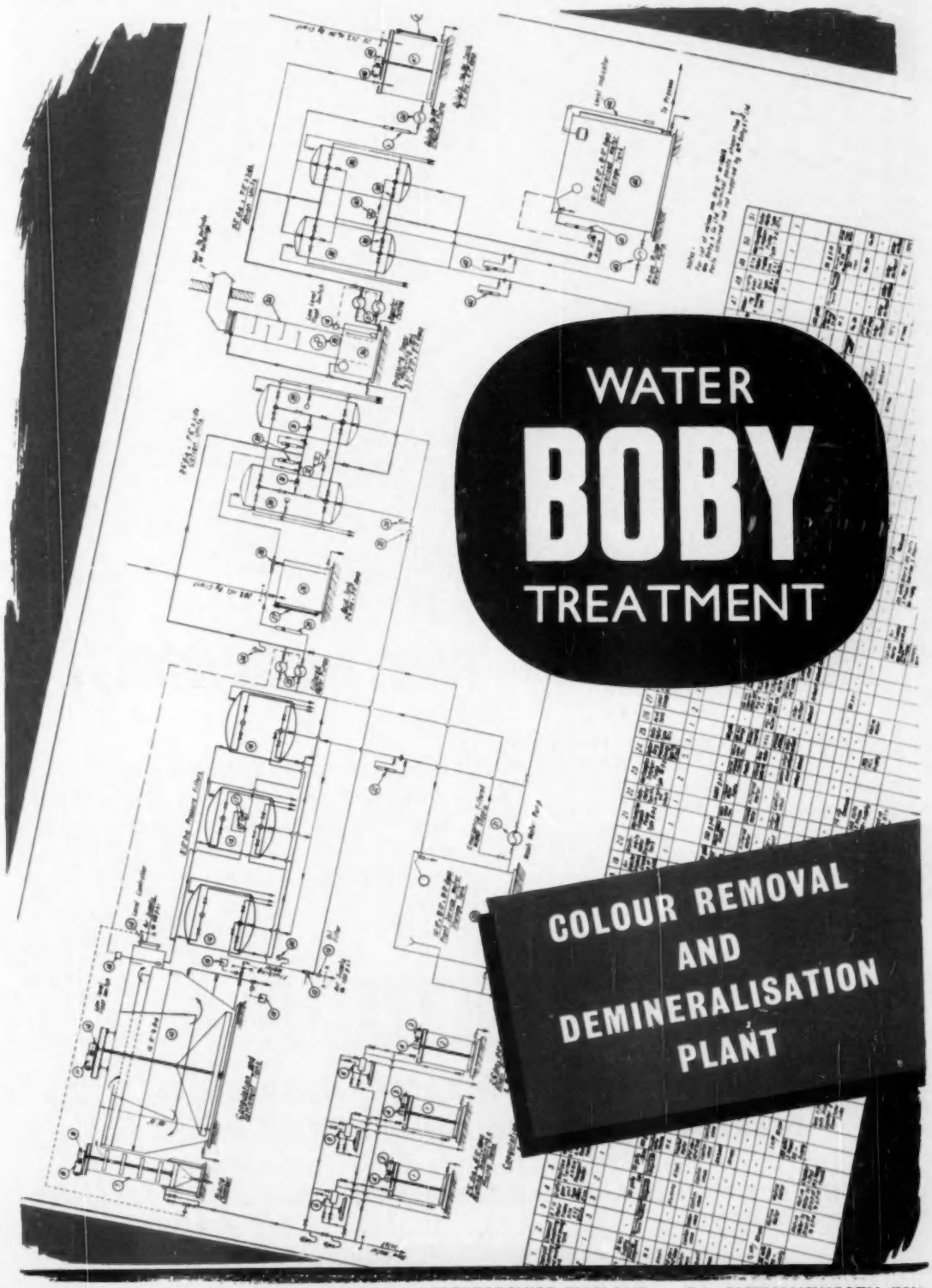

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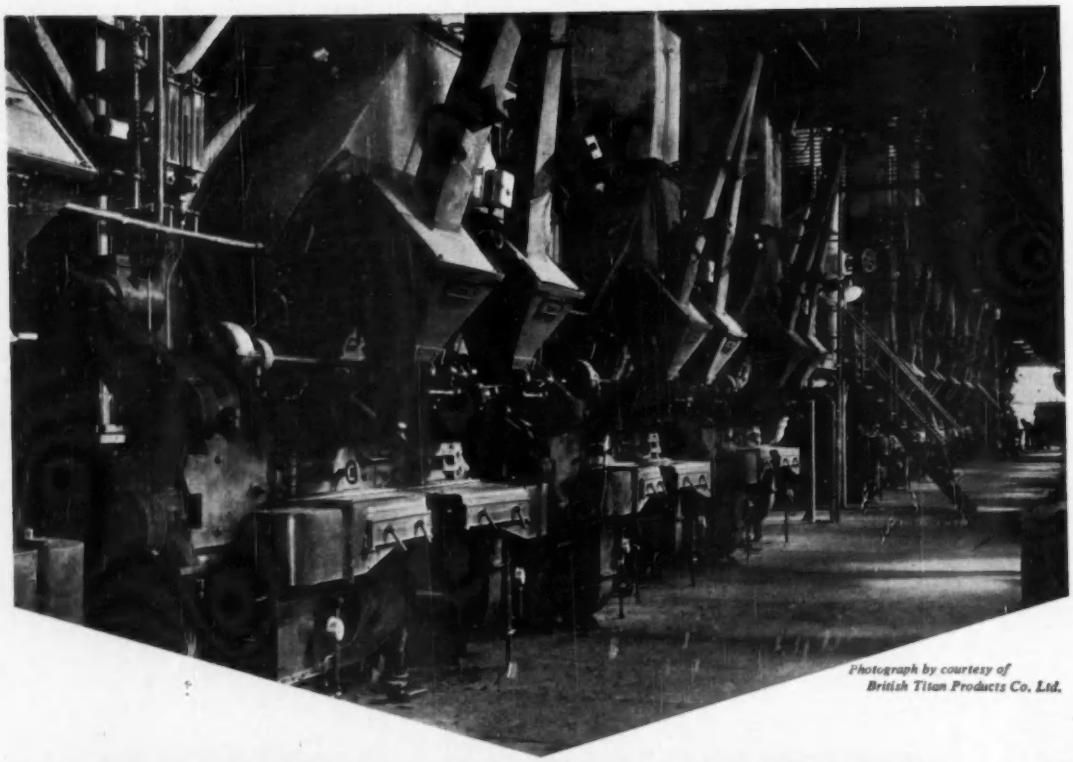

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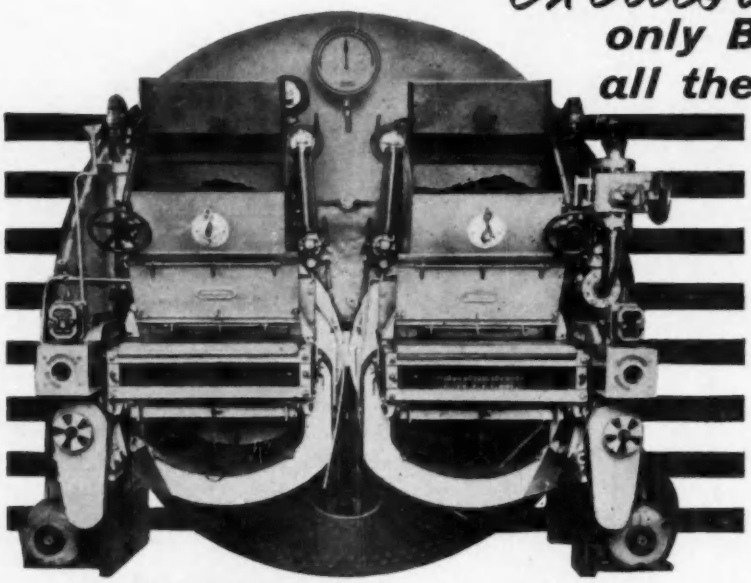

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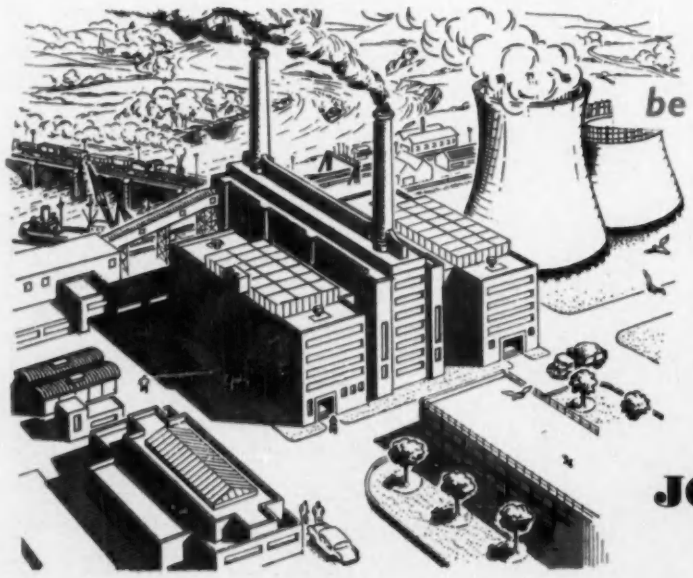

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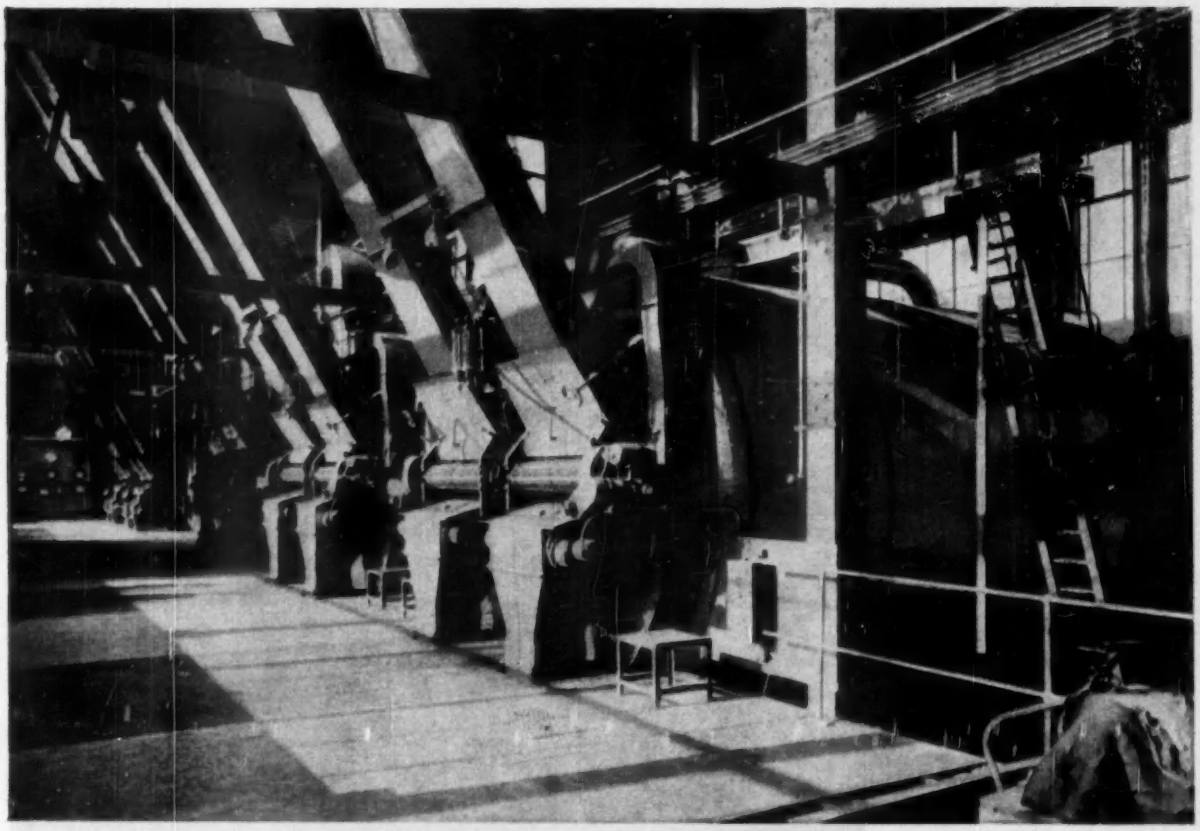

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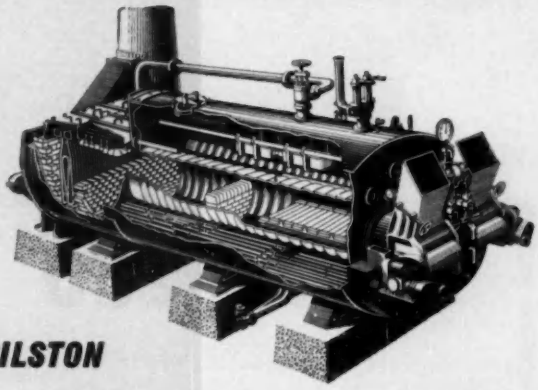

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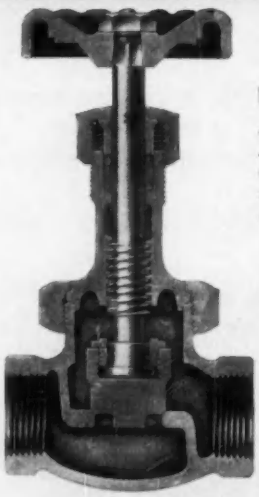

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Sizes: ¼"—2" (2½"—3" Bolted Bonnet). *Working Pressures:* Steam—up to 200 pounds. Water, oil or gas (cold, non-shock) up to 400 pounds. Hexagon ends with British Standard taper threads or to American Standards where specified.

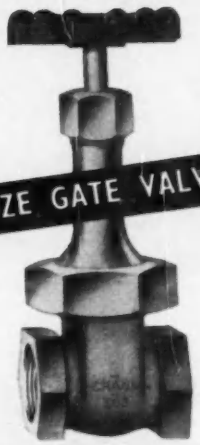
D20 REGRINDING —UNION BONNET

Sizes: ¼"—2". *Working Pressures:* Steam — up to 300 pounds (550°F). Water, oil or gas (cold, non-shock) up to 600 pounds. Hexagon ends with British Standard taper threads or to American Standards where specified.

D52 PLUG TYPE DISC—UNION BONNET

with *renewable* Nickel Alloy Disc and Stainless Steel Seat Ring. *Sizes:* ¼"—2". *Working Pressures:* Steam up to 300 pounds (550°F). Water, oil or gas (cold, non-shock) up to 1,000 pounds. Hexagon ends with British Standard taper threads or to American Standards where specified.

BRONZE GATE VALVES



D180 NICKEL ALLOY WEDGE DISC—

Union Bonnet, Integral Seats, Rising Stem. *Sizes:* ¼"—2" (2½"—3" Bolted Bonnet). *Working Pressures:* Steam—up to 200 pounds (500°F). Water, oil or gas (cold, non-shock) up to 400 pounds. Hexagon ends with British Standard taper threads or to American Standards where specified. *Also available as D181 with Stainless Steel Seats.*

D185 NICKEL ALLOY WEDGE DISC—

Union Bonnet, Integral Seats, Rising Stem. *Sizes:* ¼"—1" (1¼"—2" Bolted Bonnet). *Working Pressures:* Steam—up to 300 pounds (550°F). Water, oil or gas (cold, non-shock) up to 1,000 pounds. Hexagon ends with British Standard taper threads or to American Standards where specified. *Also available as D186 with Stainless Steel Seats.*

BRONZE CHECK VALVES

Regrinding Horizontal Valves D115 (200 pounds) and D122 (300 pounds) and Swing 'Y' Pattern Valves D142 (200 pounds) and D145 (300 pounds) are recommended for use with both globe and gate valves.

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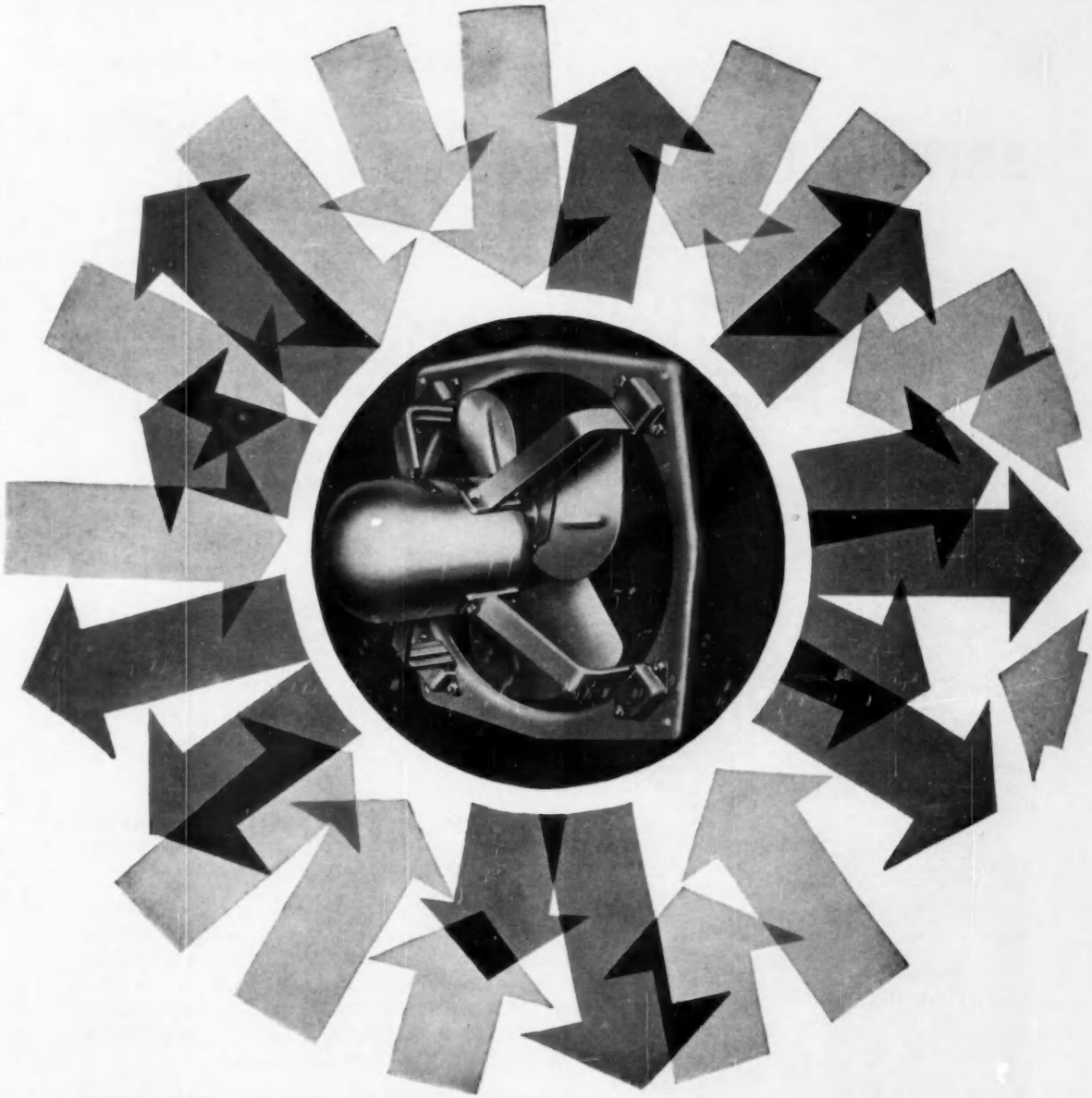

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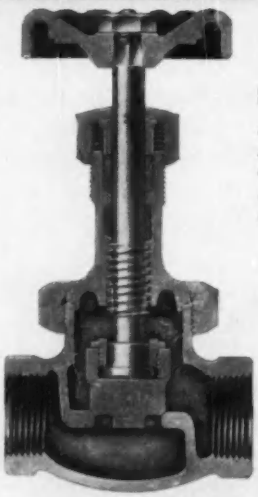

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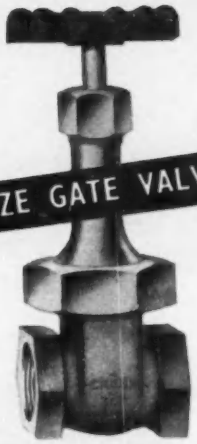
BRONZE GATE VALVES



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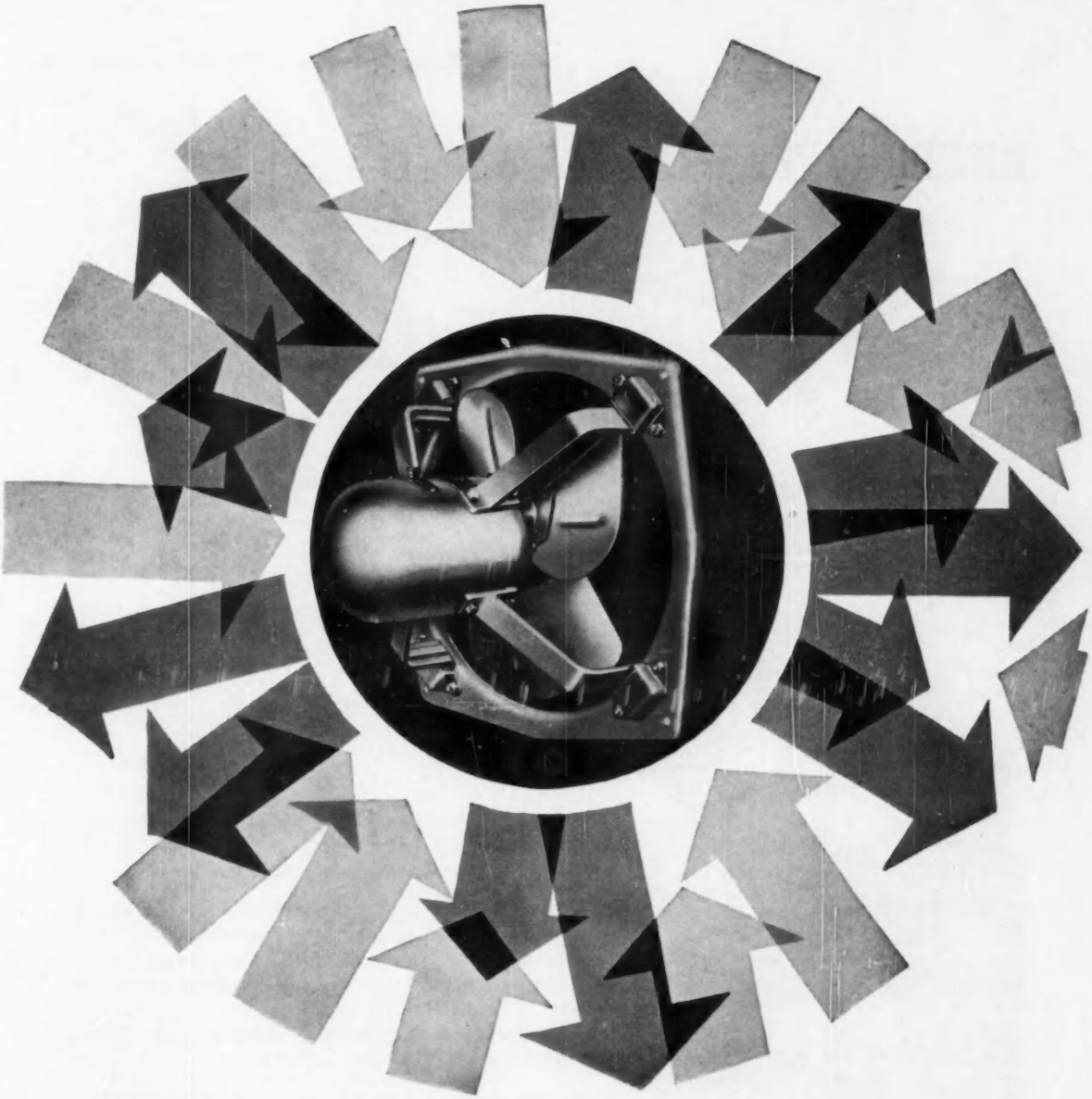

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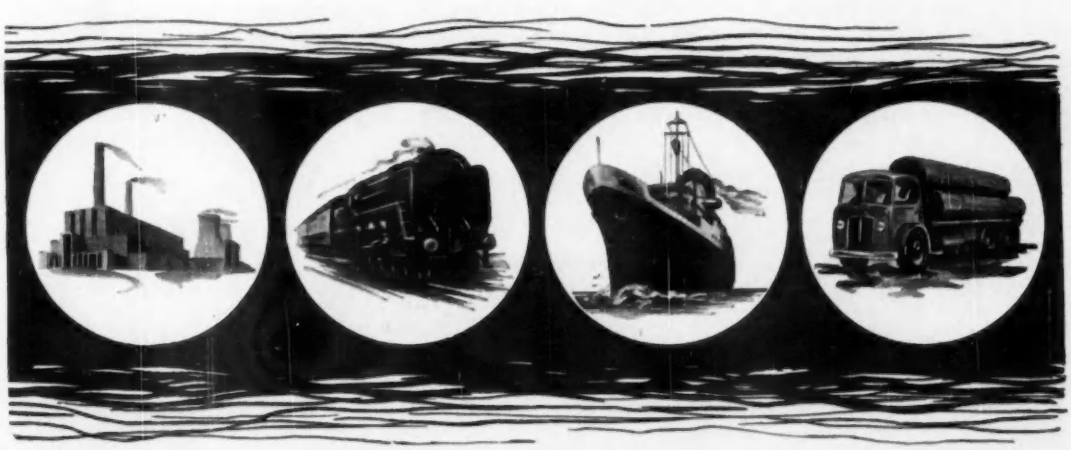

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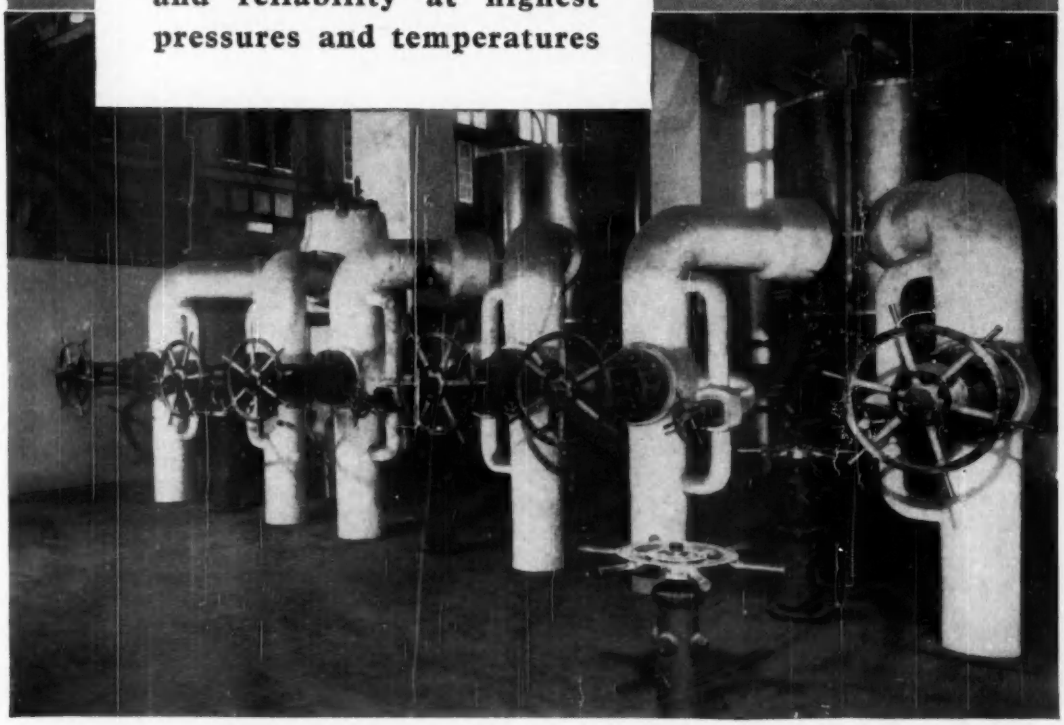

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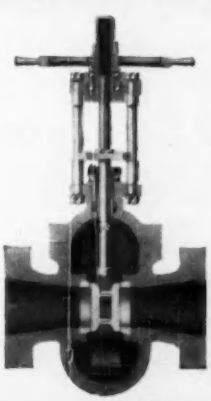

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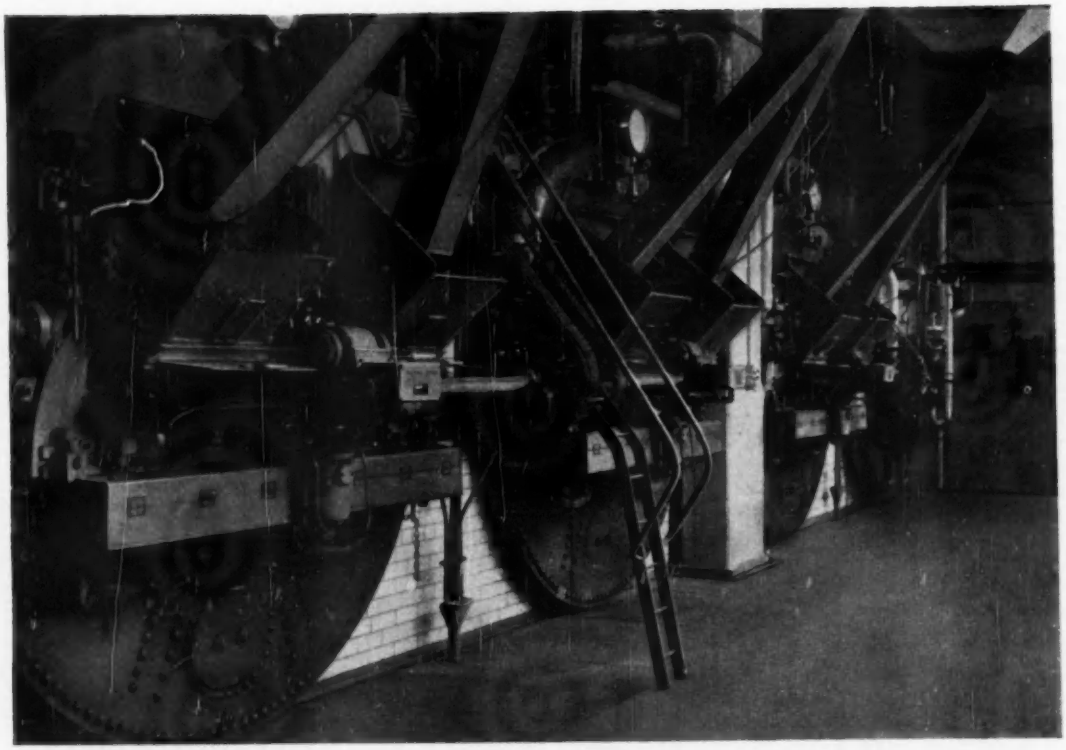

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Scale deposits on the interior of a boiler impose stresses in the metal and seriously impair the transfer of heat from the fuel to the water with the efficiency so vital for economical steam raising.

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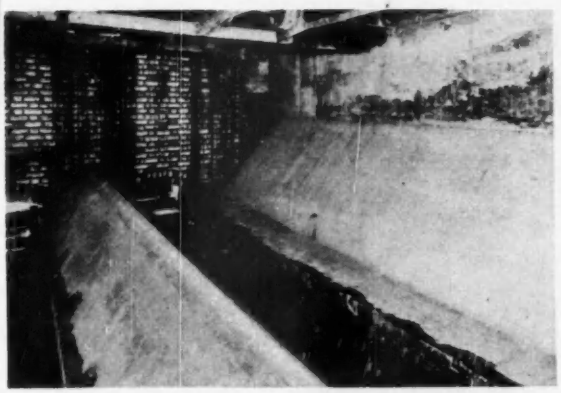
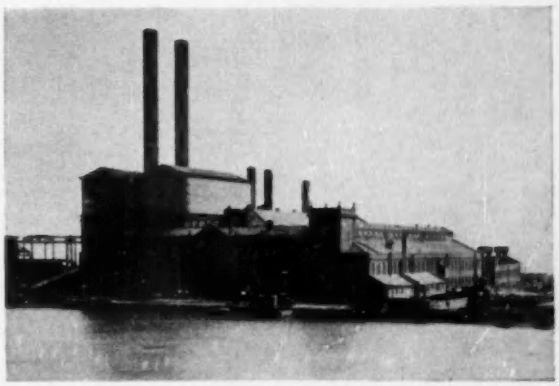
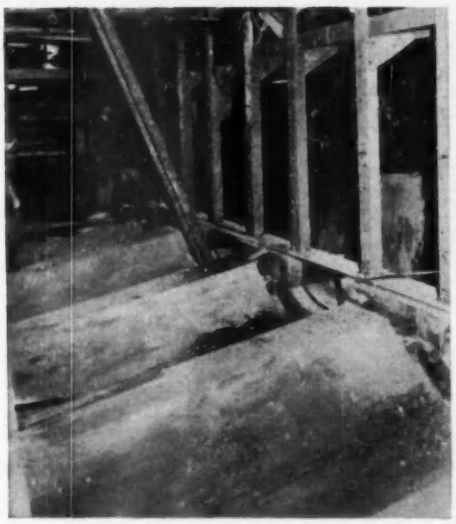


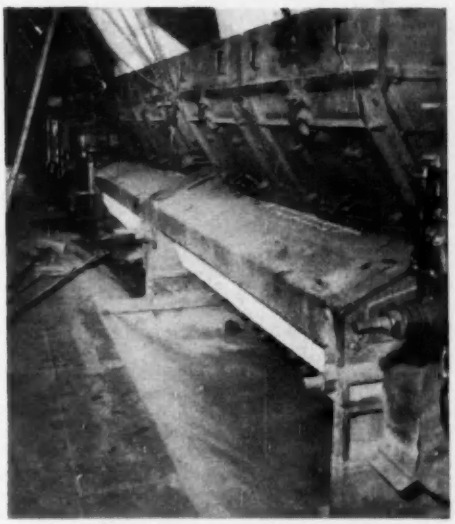
Clarence Dock Power Station. Hopper lined with ordinary Ciment Fondu concrete and the brickwork pointed with Ciment Fondu mortar.



Brighton 'A' Power Station. Ash pits and chimneys lined with ordinary Ciment Fondu concrete.



*Battersea Power Station. Ash Hopper Foundation of *Refractory Concrete designed to catch the hot burnt out ash falling from the boiler grate and wash it into the ash race. Overall size is 34' by 15' 6" by 4' 2".*



Acton Power Station. Hopper beneath chain grate stoker lined with ordinary Ciment Fondu concrete. Linings are 12' long by 2" and extend the full width of the grate.

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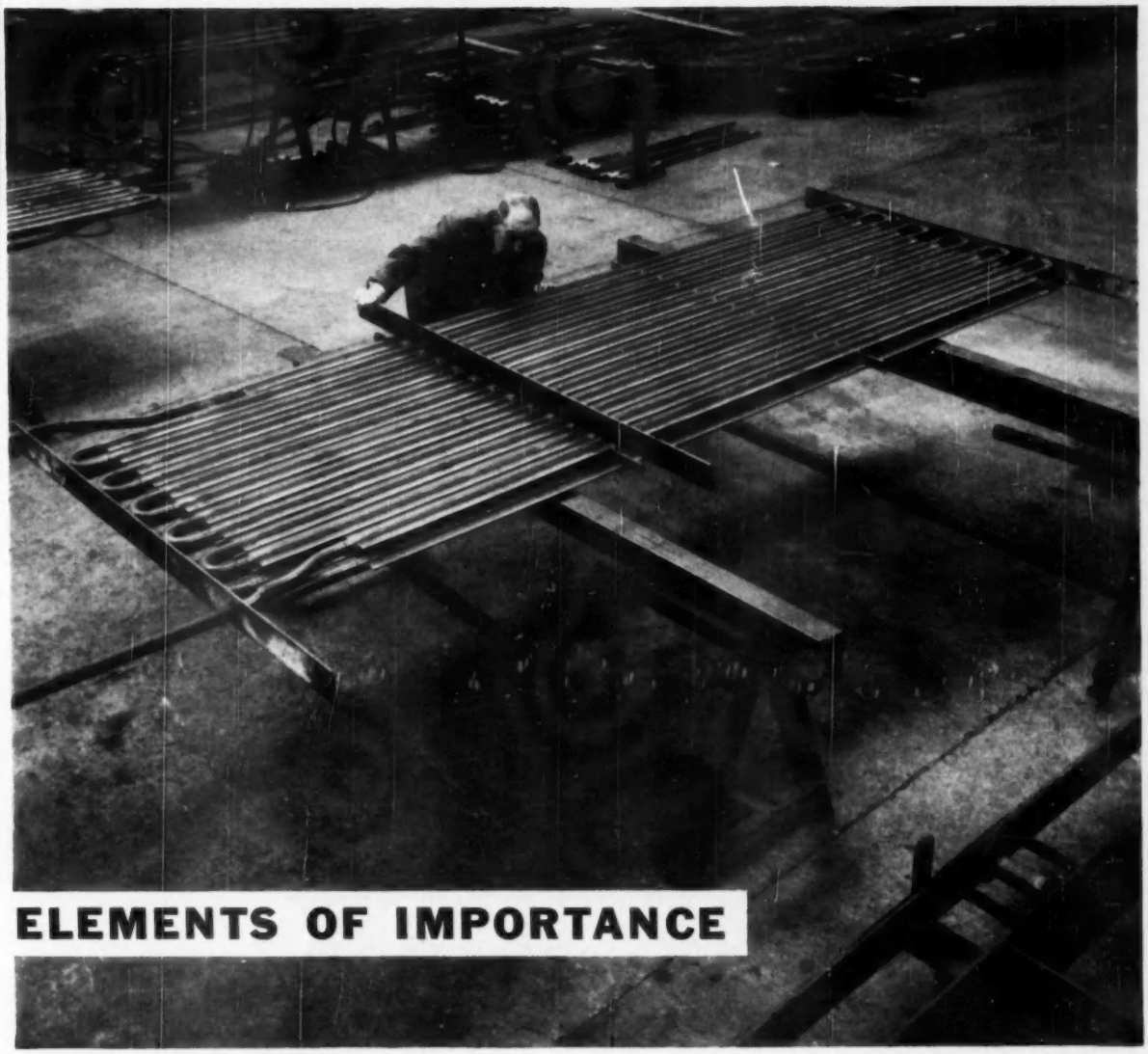

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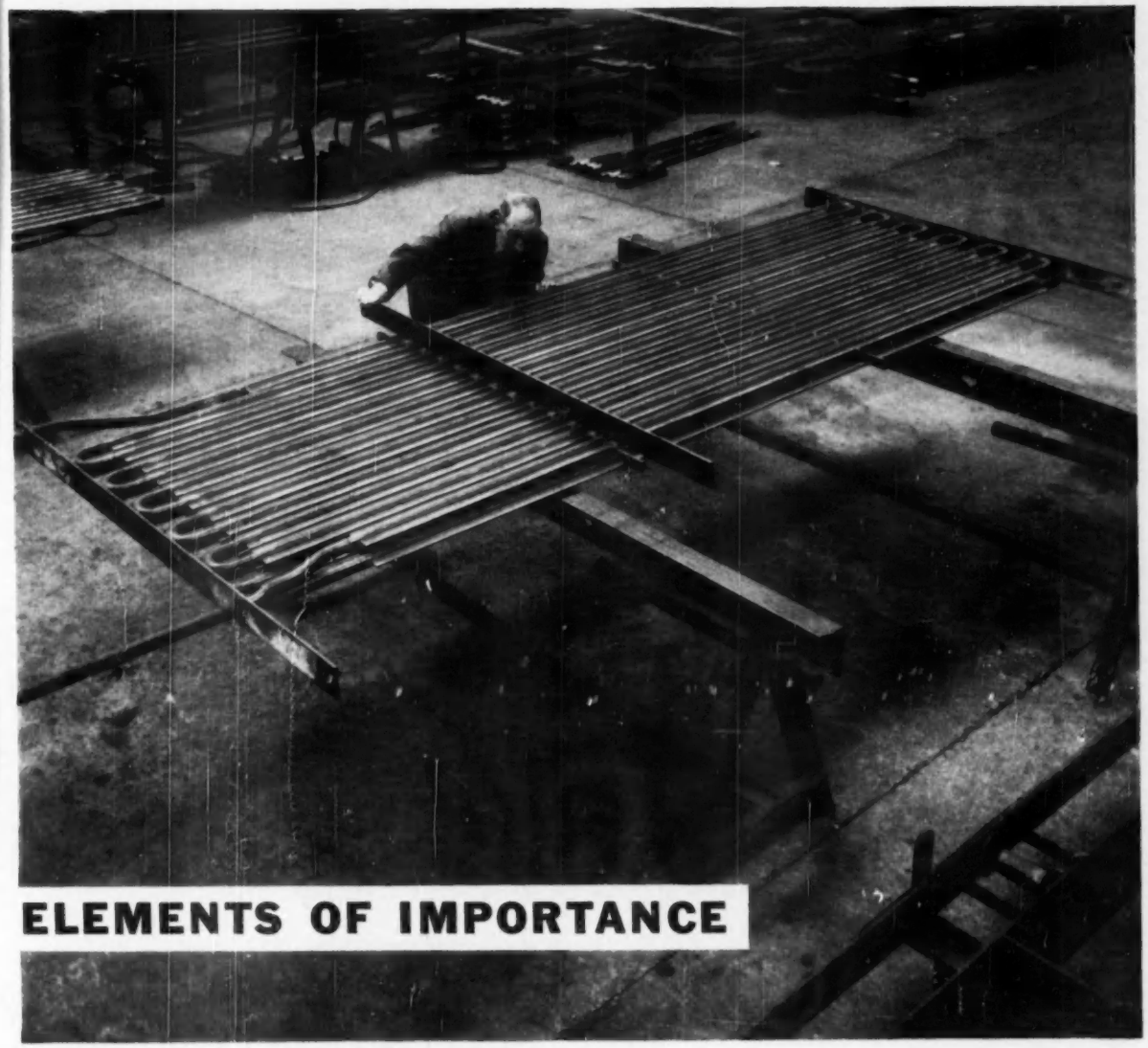

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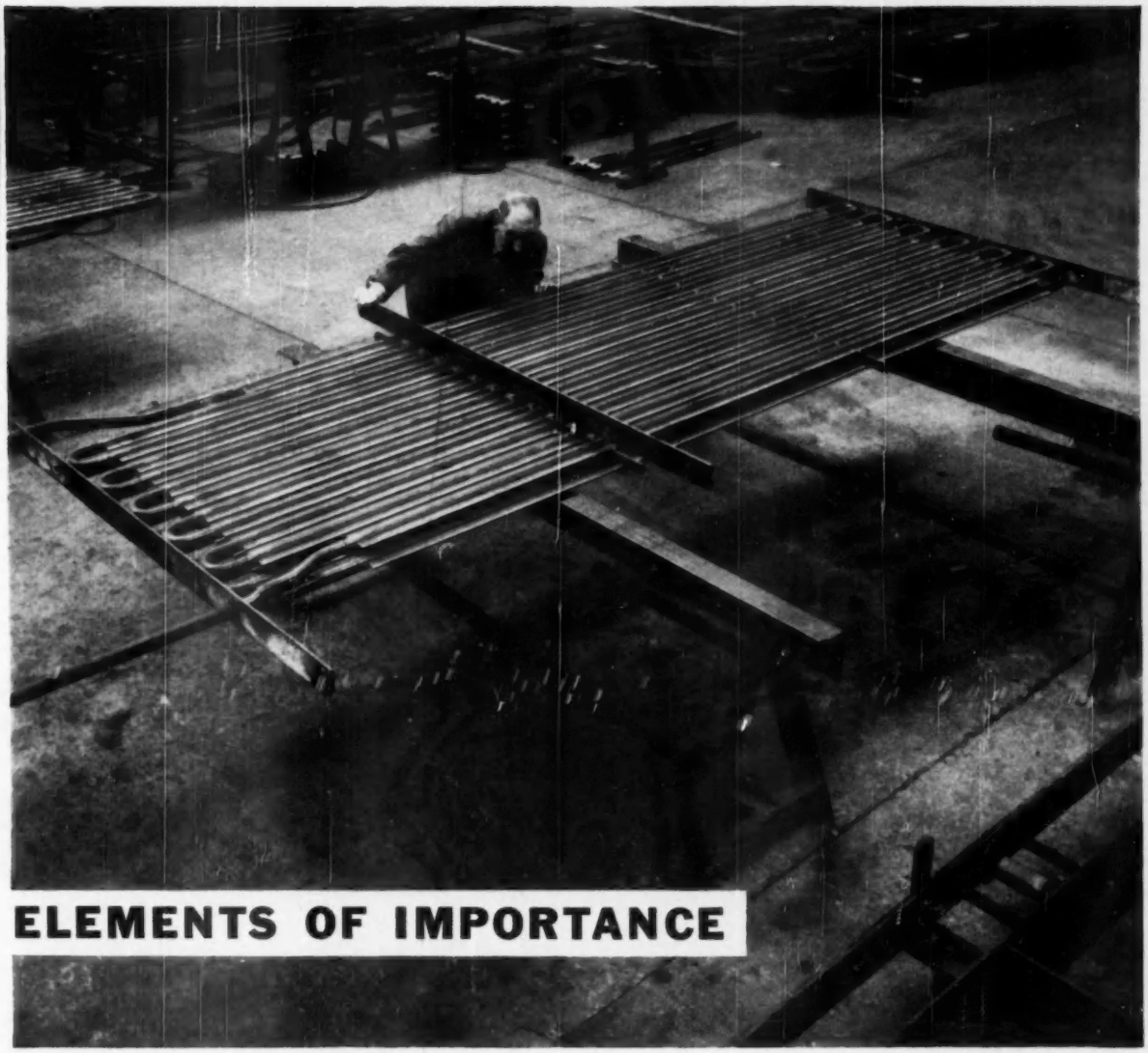

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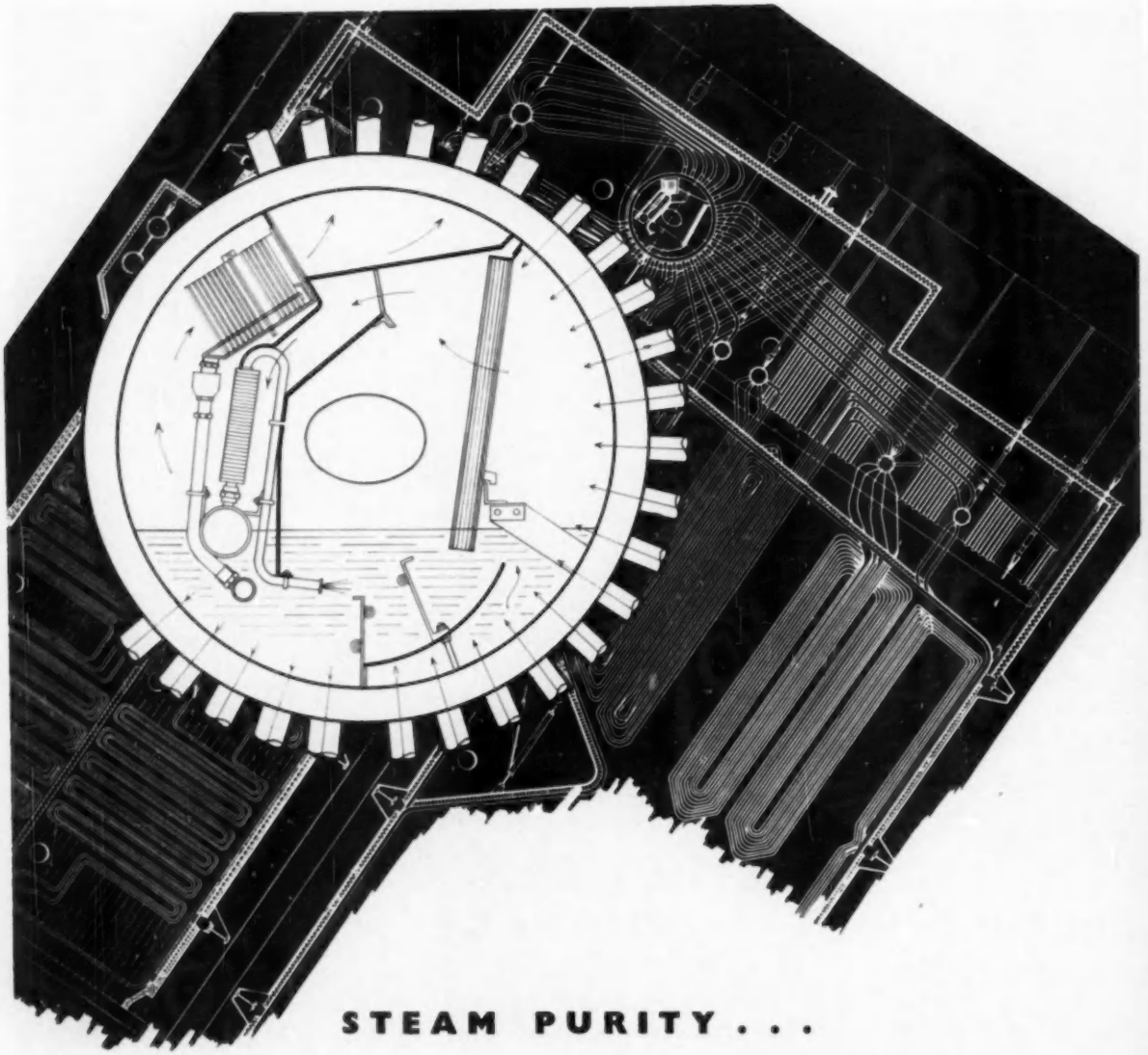

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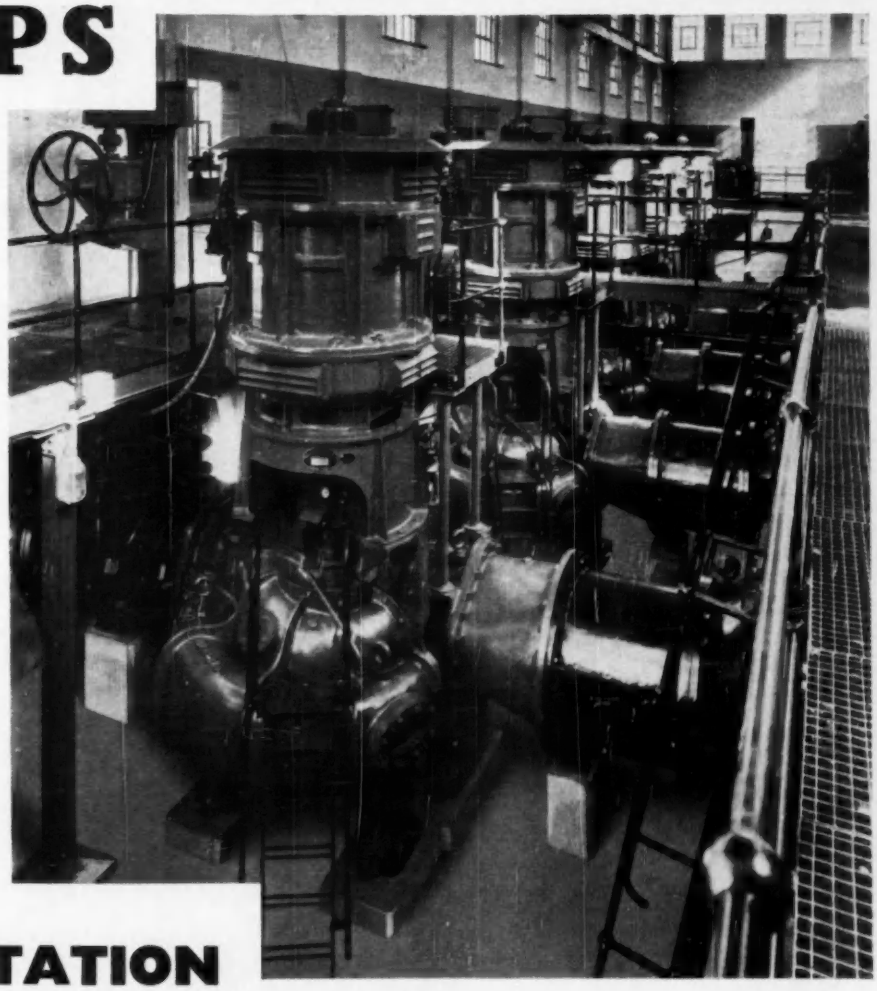

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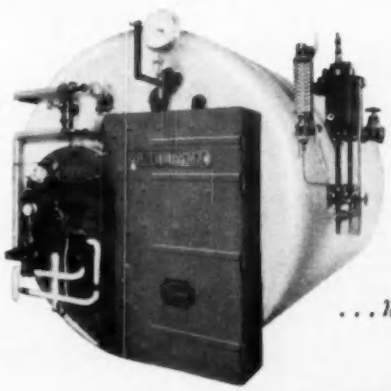

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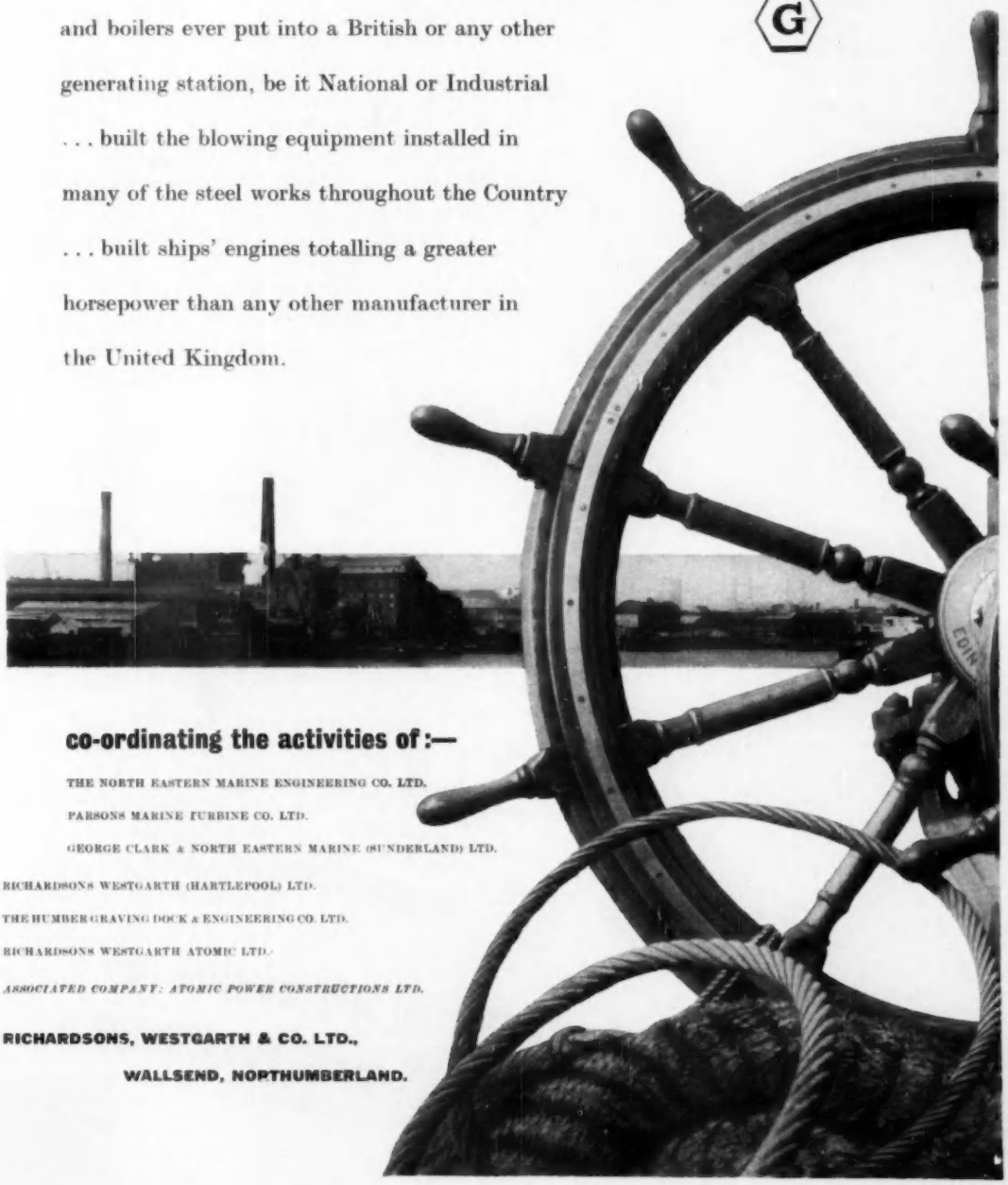

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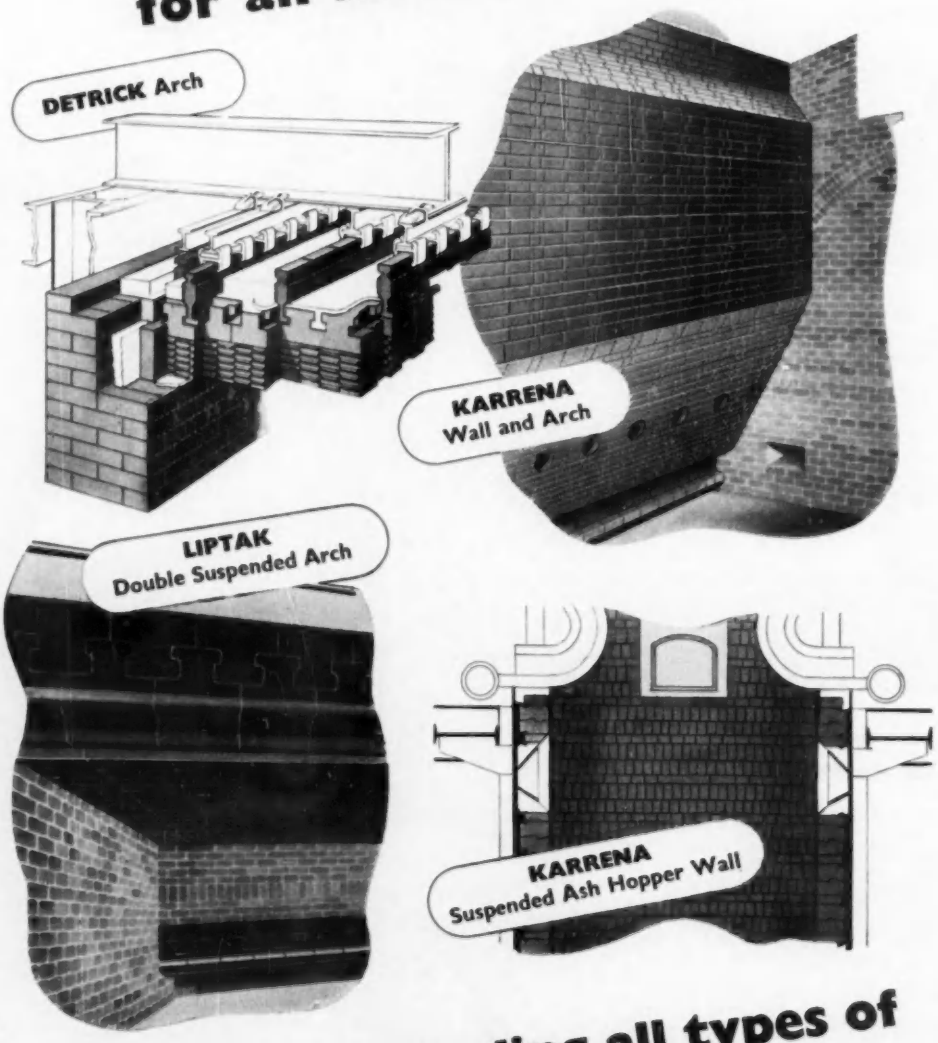

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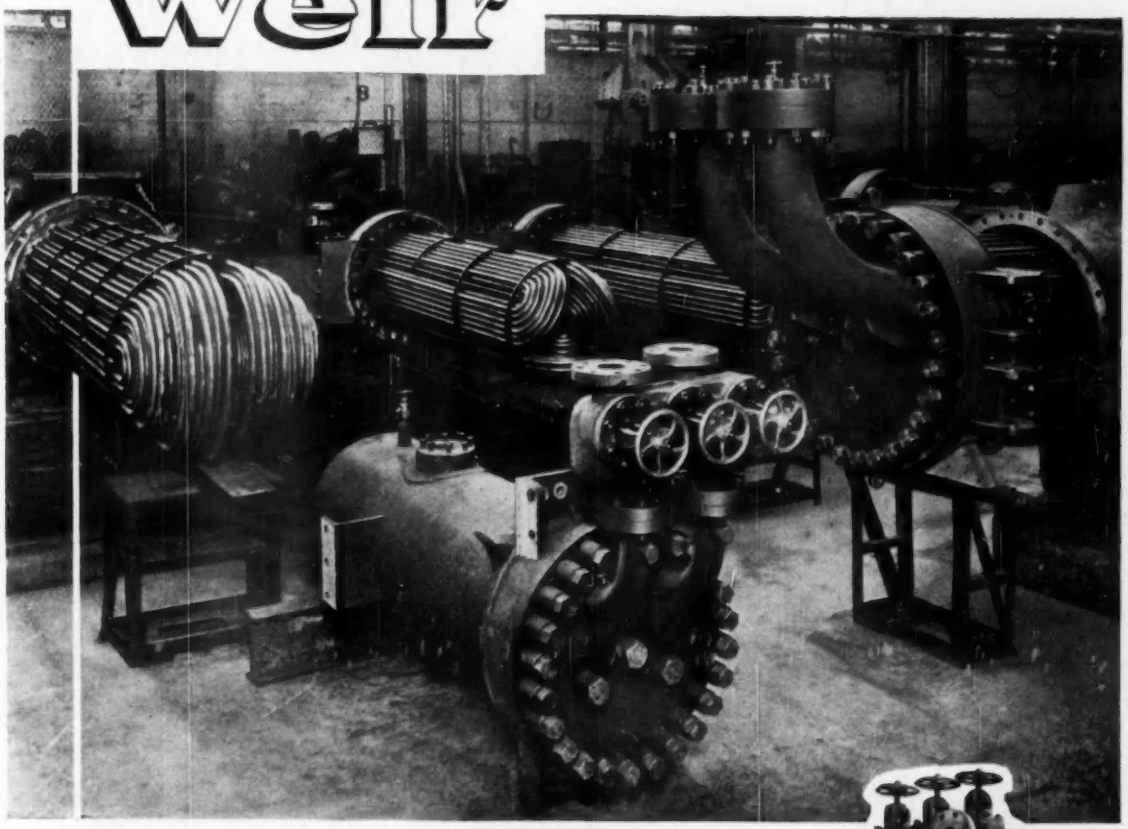

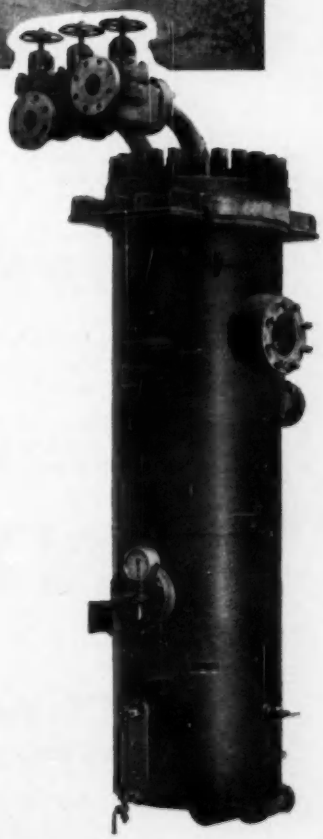

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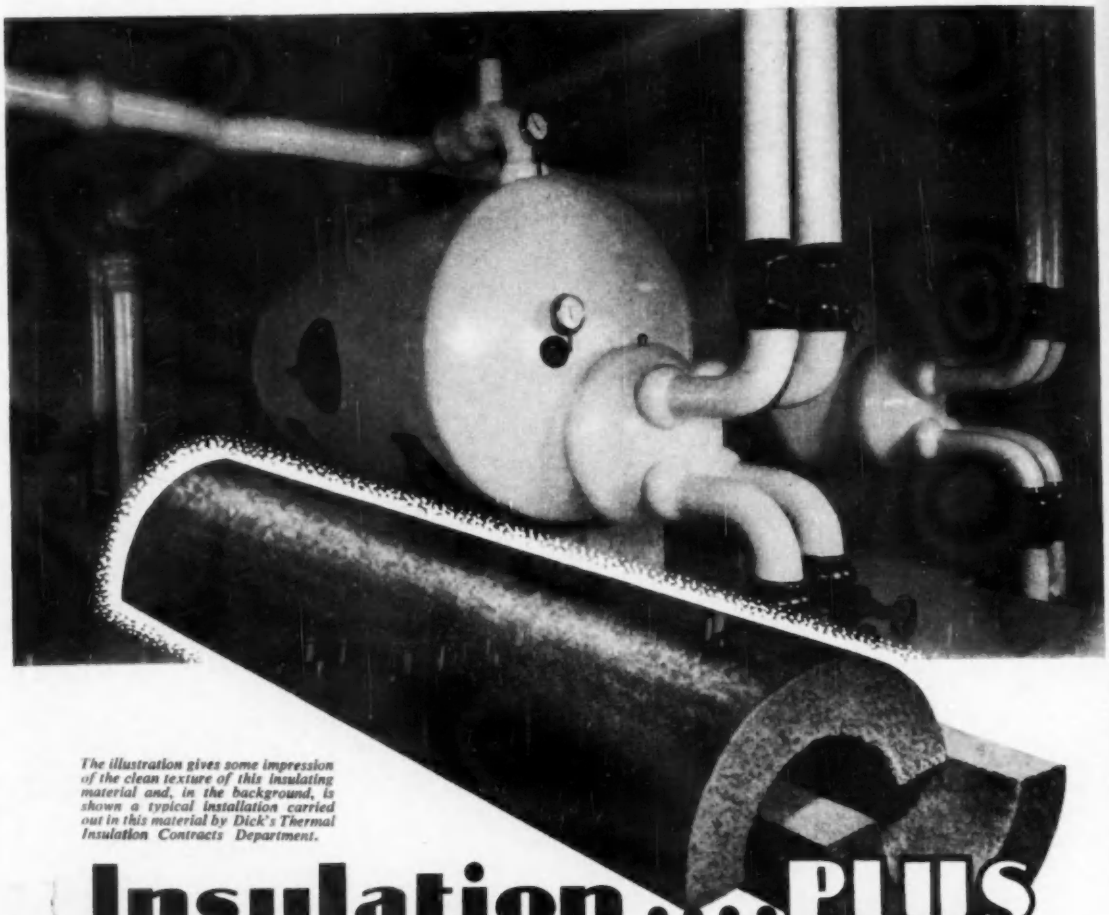

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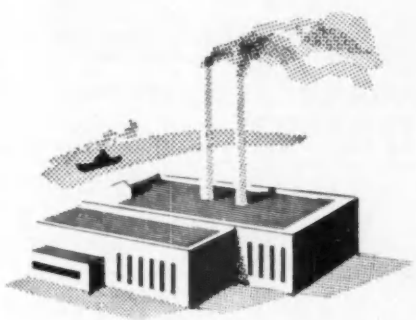

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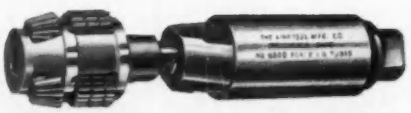

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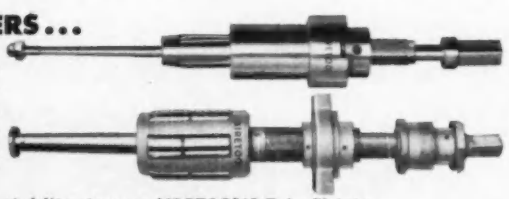

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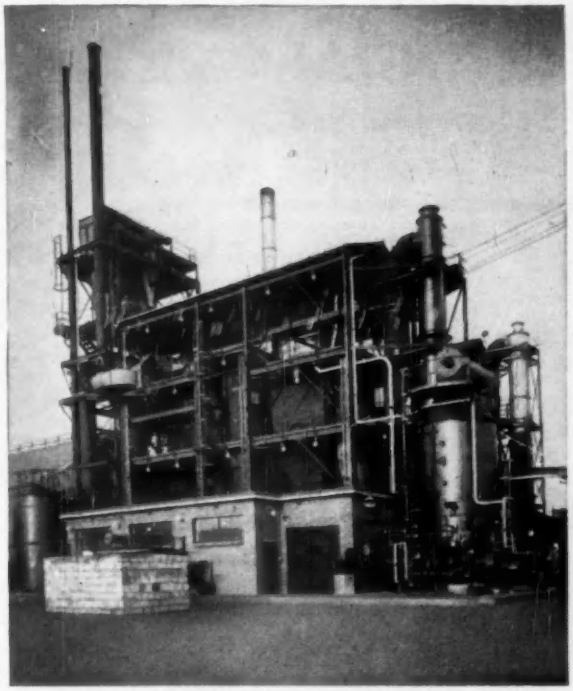

A Holmes-Elex Electrical Precipitator installed on a plant for the collection of lamp black.

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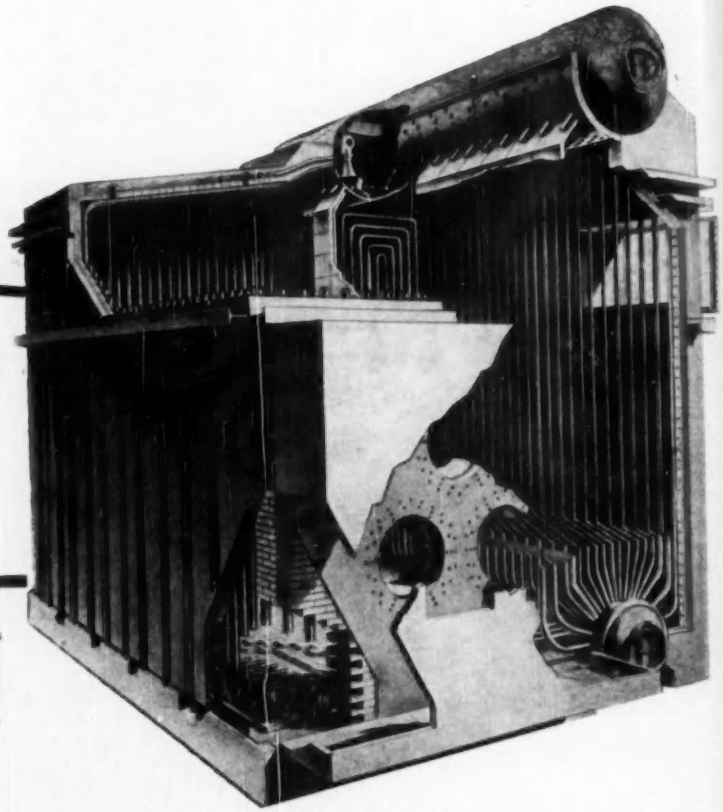

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Steam pressures : to 1500 psi.
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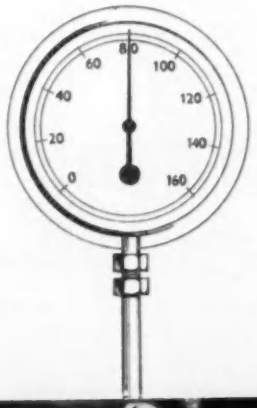

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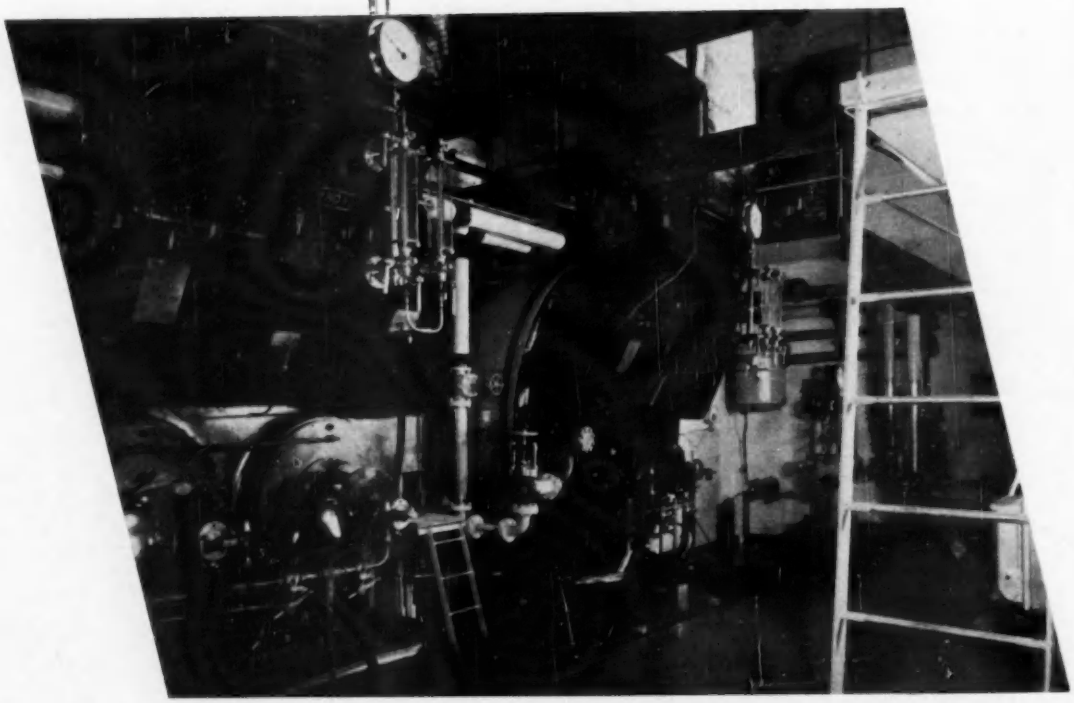

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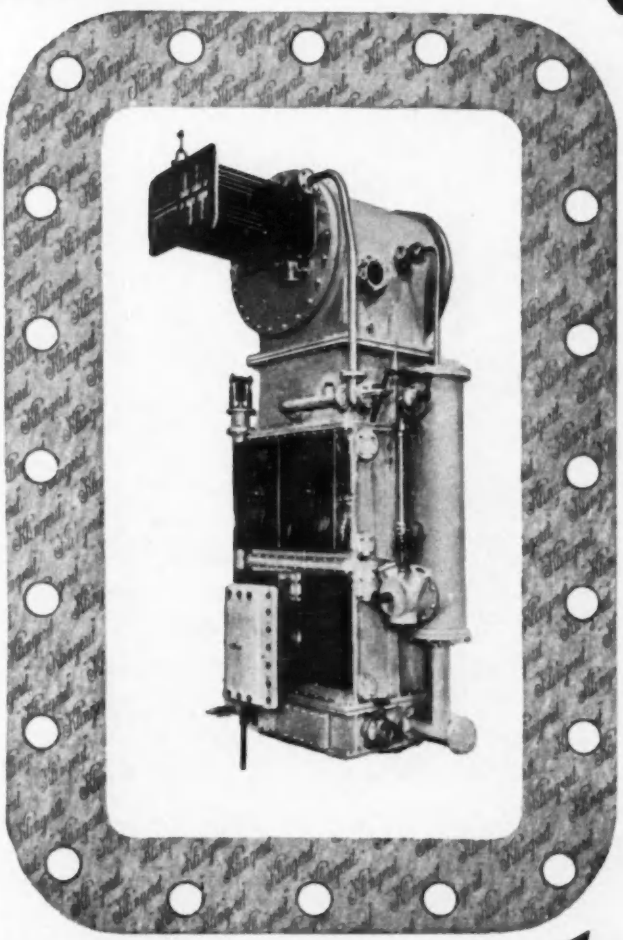

"Klingerit" joints used on the Preheater Condenser tubeplates in an Aiton 20 Tons per day Marine Type Evaporator Distiller. (Photograph by kind permission of Messrs. Aiton & Co. Ltd., Derby.)

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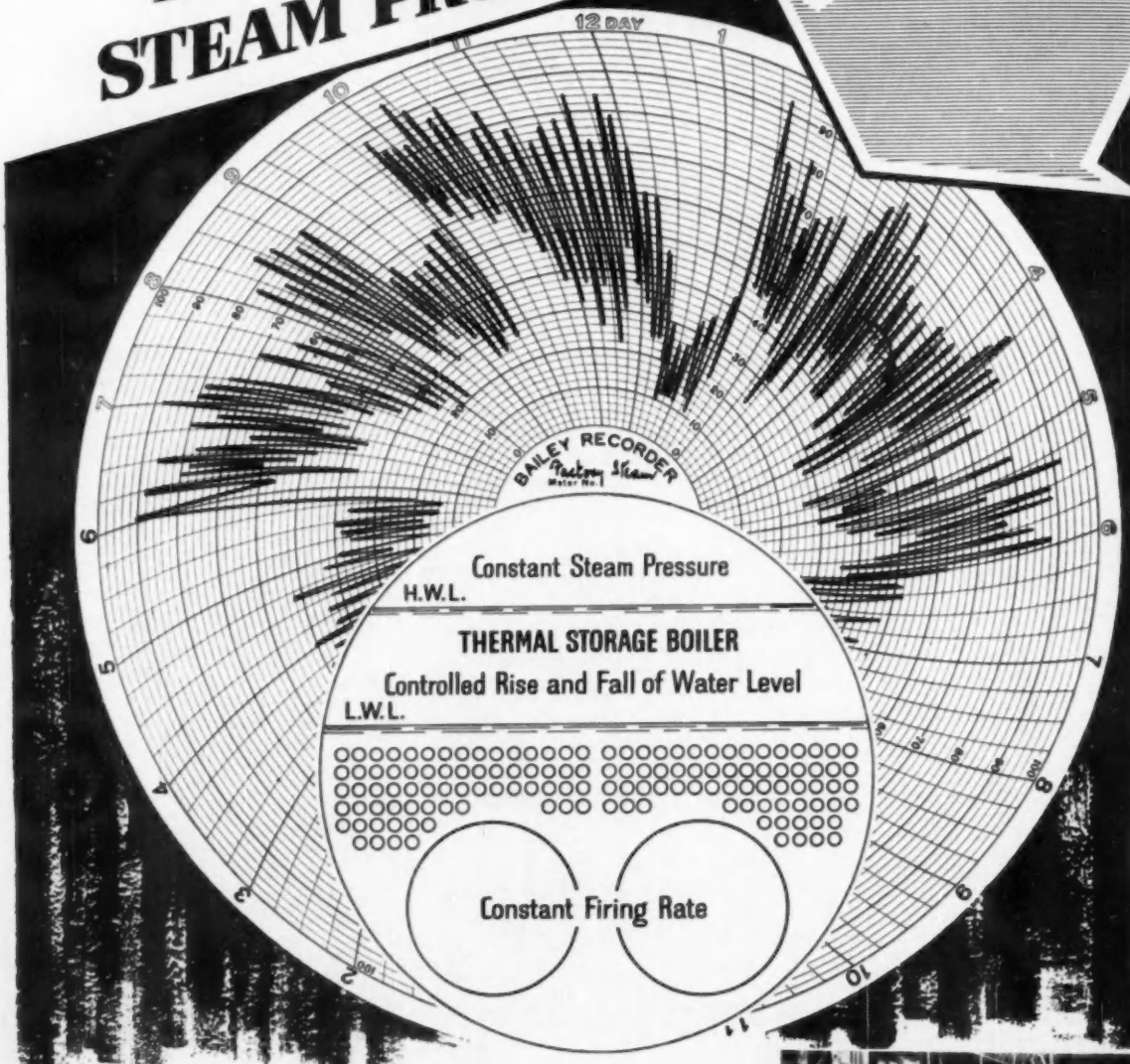

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Engineering and BOILER HOUSE REVIEW

THE OLDEST ESTABLISHED STEAM ENGINEERING PUBLICATION

JANUARY 1958

VOLUME 73. No. 1

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Published monthly by

ENGINEERING REVIEW PUBLISHING CO. LTD.
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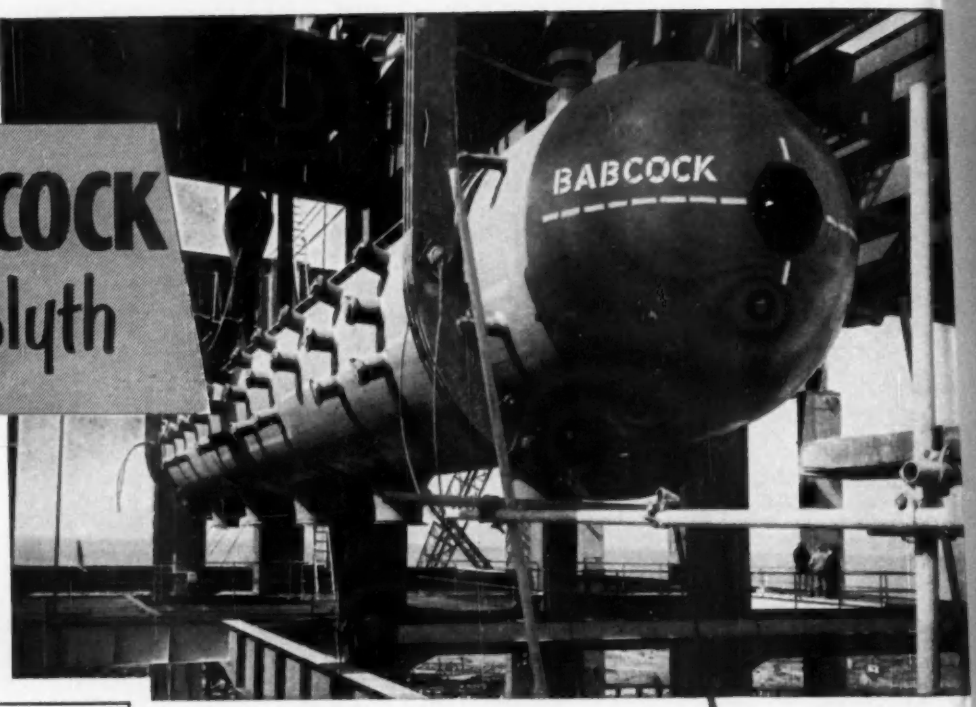

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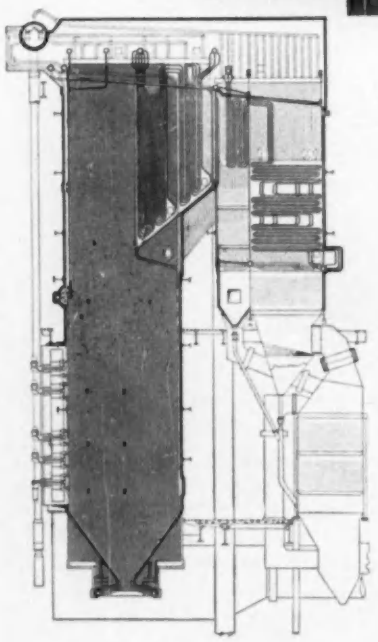

Four 860,000 lb/hr. boilers

Steam Conditions: 1600 lb./sq. in., 1010°F. with Reheat to 1005°F.

From drum-level 137 ft. above ground, Babcock engineers erecting the boilers at the new Blyth power station (N. E. Division, C.E.A.) look out over the flat lands at the mouth of the River Blyth, at Cambois, Northumberland.

The four Babcock boilers, each to steam a 120 MW turbine, will rank among Europe's largest. They are single-furnace Radiant units, each p.f. fired by 20 horizontal, circular-type burners, which are in 5 tiers and cross-connected to the 5 type EL70 pulverizing mills per boiler, to provide flexible operation and even flame distribution.

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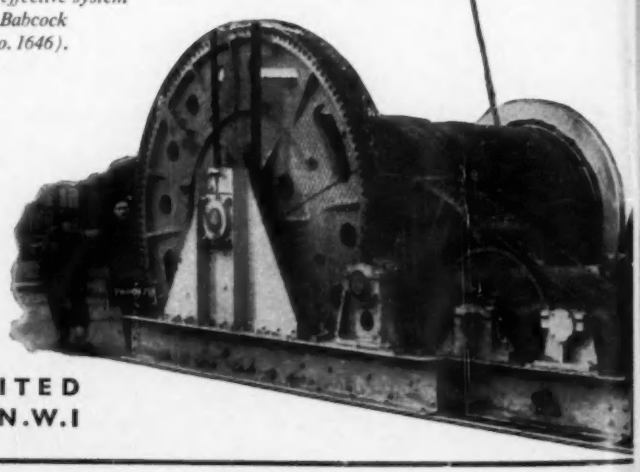

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REORGANISATION OF ELECTRICITY SUPPLY INDUSTRY

DETAILS have been announced by the Central Electricity Generating Board of some of the main aspects of the reorganised structure of the electricity supply industry under the provisions of the Electricity Act, 1957. Elsewhere in this issue we include reference to the appointments of some of the chief officers and the positions which they will occupy under the new arrangement.

Briefly, the existing Generating Divisions, which number eleven, are retained, but they are now grouped in five regions under "Regional Directors." The existing technical organisations will remain under the divisional controllers, but accountancy and some administrative functions will gradually be brought together at the regional offices. At the same time three "Engineering Project Offices" have been created, and these will be responsible for the construction of new power stations—conventional as well as nuclear, and major extensions to existing stations, within the flexible boundaries of the areas for which they are responsible. Project offices, or rather the three chief project engineers, will be able, by arrangement, to undertake the handling of projects in adjoining areas. Three separate engineering project offices have been established in view of the fact that the character of the industry's growth makes it impossible to achieve a uniform load on the construction staffs of the generating divisions, and even, to some extent, of the five newly-established regions.

It will be remembered that when the electricity supply industry was nationalised under the 1947 Electricity Act, one of the main effects was to separate electricity generation (plus the functions of main transmission), from distribution. Under this Act, the main and direct responsibility of the British (later Central) Electricity Authority was to develop and maintain an efficient, co-ordinated, and economical system of electricity generation throughout the country, and supply in bulk to Area Boards for distribution. At the same time the Central Authority was given what was virtually, general control of the industry in that it was required so to discharge its functions as to secure that the combined revenues of the Authority and the Area Boards taken together were not less than sufficient to meet combined outgoings taking one year with another.

But in 1954, only six years after vesting date, the Government set up a committee under the chairmanship of Sir Edwin Herbert "to enquire into the organisation and efficiency of the electricity supply industry in England and Wales in the light of its working under the Electricity Act, and to make recommendations"; it indicated that they were considering the question of making some changes in the organisation. It was the opinion of the Herbert Committee that the original arrangement of the organisation was unsatisfactory for several reasons: for example, it was thought that the general set-up rather hindered the expeditious design and construction of power stations because of the vast amount of committee work which had grown up around the system; also, the Area Boards complained that difficulties and interference were sometimes created in connection with the conduct of their affairs. However, when the full report of the Herbert Committee was published, many of its suggestions and recommendations were open to such adverse criticism that many people wondered whether, in fact, the Government would take very much action, in spite of the fact that it was clear that the Government favoured decentralisation. One of the recommendations of the Herbert Committee was that the Central Authority should be dissolved and that the Area Boards should become autonomous, and be relieved of overall control hitherto exercised by the Central Authority. In essence that is actually the character of the organisation which has now been set up, with the Electricity Council at the summit. The membership of the Council comprises a chairman, two deputy chairmen, and numbers among its members all the chairmen of the Electricity Area Boards, and the chairman and two other members of the Central Electricity Generating Board.

The Council *inter alia* have an overall responsibility for research in the industry, and apart from certain necessary alterations in membership, the conciliation and consulting machineries for the industry will continue in their present form. The main functions of the Council are clearly indicated by the fact that its chief officers are described as advisers for finance; commercial and development; industrial relations; and, of course, secretarial and legal.

Points and Pointers

ELECTRICITY COUNCIL RESEARCH AND TRAINING ESTABLISHMENTS

The Electricity Council announces that in accordance with the provisions of the Electricity Act, 1957, agreement has been reached between the Council and the Central Electricity Generating Board regarding the transfer to the Council and the Board of the assets of the Central Electricity Authority and the contracts of service of the staffs. The Council states, *inter alia*, that since it has an overall responsibility for research in the industry, the research laboratory buildings at Leatherhead, Surrey, will be vested in the Council. At the same time, it is realised that at the moment more than 80 per cent. of the work at Leatherhead concerns the generation and transmission side of the industry, and it has, therefore, been agreed that the contracts of service of the staff at Leatherhead will vest in the Generating Board pending further consideration of the type of research to be carried out by the Council and Generating Board respectively. It has been agreed that one of the two training centres of the Central Electricity Authority must be preserved as a residential college for the industry as a whole and, for this purpose, the centre at Horsley Towers, Surrey, will be vested in the Council. The training centre at Buxton will be vested in the Generating Board, but there will be reciprocal arrangements between the two bodies for certain Area Board and Electricity Council courses to be held at Buxton and for certain Generating Board courses to be held at Horsley Towers. The Council states that apart from certain necessary alterations in membership the conciliation and consulting machineries for the industry will continue after January 1st in their present form.

RATING OF PLANT AND MACHINERY

The Minister of Housing and Local Government, has appointed a committee to prepare a new list of all the types of plant and machinery which are rateable. This information was given in an answer to a question in the House of Commons on December 6th. The chairman of the committee is Sir Edward H. Ritson, K.B.E., C.B., until recently deputy-chairman of the Board of Inland Revenue. The committee is composed of experts in rating matters and includes a Queen's Counsel, a chartered surveyor, and members of the civil, electrical and mechanical engineering institutions. The members are Mr. Maurice Lyell, Q.C., Mr. T. S. Dulake, F.R.I.C.S., Mr. C. H. Pickworth, M.Inst.C.E., M.I.E.E., and Mr. A. B. Henderson, M.A., M.Inst.C.E. The terms of reference of the committee are :—"To prepare in accordance with subsection (6) of Section 24 of the Rating and Valuation Act, 1925, a revised statement setting out in detail all the machinery and plant which appears to the committee to fall within any of the classes specified in the Third Schedule to that Act. It will be open to the committee to review the interpretation of the Third Schedule and the existing Plant and Machinery Order as it has developed in practice since the Schedule was enacted, and to recommend any changes in the interpretation thereof for the purpose of preparing the revised statement. It will also be open to the committee to draw attention to any desirable amendments to the Third Schedule to permit of greater clarity and precision in the drafting of the revised statement, always provided that such amendments do not involve a material change in the general concept of the rating of plant and machinery as now laid down in the Schedule. In either case the committee should indicate what differences in the revised statement would result from any change of interpretation, or amendments to the Third Schedule, as the case may be." Before 1925 practice varied widely over the rating of plant and machinery. The Rating and Valuation Act of 1925 sought to achieve uniformity by laying down in Section 24 that only those kinds of plant and machinery specified in the Third Schedule to the Act were to be rated. The Third Schedule listed four classes : (i) Items connected with : (a) the generation, storage, primary transformation, main transmission of power ; or (b) heating, ventilation and lighting, etc. (ii) Passenger lifts and elevators. (iii) Railways and tramways. (iv) Certain items "in the nature of building or structure." A committee was appointed under Section 24 to list in detail the items which appeared to fall within these classes, and the committee reported in 1926. The Minister confirmed the list, after modification, in the Plant and Machinery (Valuation for Rating) Order, 1927. (S.R. & O. No. 480). The Order is decisive in determining which kinds of plant and machinery are to be included in the assessment of factories, mines, etc., and which are to be ignored, and it has not been revised since. The advance of technology has resulted in the development of many new types of machinery, and the Order has become more and more out of date. This has led to expensive litigation. The committee is inviting evidence from professional institutions and representative industrial associations. Any other body or person wishing to offer their views to the committee should communicate in writing with the Secretary, Mr. N. Hamilton, of the Ministry of Housing and Local Government.

THE DIPLOMA IN TECHNOLOGY

The National Council for Technological Awards in its first report published recently states that the Government's plan to produce the necessary supply of technologists through the technical colleges can only succeed if the colleges, industry and the Council are able to pool their experience and ideas and produce suitable courses in the various technologies. The report describes the work of the Council since it was set up at the end of 1955 under the chairmanship of Lord Hives, to create and administer for technical college students awards of

high standard, equivalent, in fact, to university honours degrees. The first step was to issue 18,000 copies of a memorandum setting out the basic requirements of the courses which the Council would recognise. By July 31st, 1957, 83 courses out of 123 applications had been considered. Twenty-nine existing courses in nine colleges were recognised as leading to the new diploma, 20 proposed new courses also satisfied the Council's requirements, and 34 courses were rejected. It is stated that consideration of the remaining courses is proceeding with all possible speed. The Council are convinced that this response confirms the urgent need for a high award for technical college students. Although their insistence on high standards has meant the rejection of a considerable number of courses, the Council hope that developments now taking place at the colleges will enable them to recognise many of them in the near future. In his foreword to the report, Lord Hives states that on November 21st there were 965 students at 11 colleges attending 37 courses recognised as leading to the diploma in technology. As part of the procedure for the approval of courses, members of the Council visited and reported on the colleges concerned in order that a "full and serious examination for a just appraisal" could be made. The Council regard a course leading to the diploma in technology as a complete entity, the industrial training being just as much a part of the course as the academic study. The report emphasises that integration of academic and practical training in industry must be an essential part of any course.

BOILER AVAILABILITY COMMITTEE

The Boiler Availability Committee, which consists of representatives of the Central Electricity Authority, the South of Scotland Electricity Board, the Water-Tube Boilermakers' Association, the British Coal Utilisation Research Association, the Fuel Research Station of the Department of Scientific and Industrial Research, and other manufacturers of boiler plant equipment, recently issued its ninth bulletin (MC/286), *Methods of Cleaning Modern Boiler Plant*. This is a revision of its first bulletin, extended to include external cleaning of pulverised-fuel-fired as well as stoker-fired boilers. Copies are obtainable from manufacturers of water-tube boilers. Whilst most of the methods described are probably applicable to oil-fired plant also, there is no widespread experience in Great Britain with large boilers fired with residual oil fuel, and the committee therefore recommends caution until further experience has been obtained. In 1945 the amount of coal burned in British power stations in pulverised form was not outstandingly large, yet in the twelve months ended March, 1957, about 25,500,000 tons were burned in pulverised form, representing 57 per cent. of the total solid-fuel consumption in power stations, and this percentage is rapidly increasing. The investigations made by the committee are now almost entirely long-term. In recent years close liaison has been instituted with the A.S.M.E. Research Committee on Corrosion and Deposits from Combustion Gases, particularly with regard to large oil-fired boilers. More recently Electricité de France has co-operated in similar investigations. Teams of research workers of the B.A.C. have made visits to French power stations, notably at Nantes Chevire on 500,000 lb./hr. oil-fired boilers. In addition to laboratory-scale investigations by the research bodies, the Research Department of the Central Electricity Authority and many of the boilermakers, large-scale investigations are also being conducted in many of the power stations operated by the C.E.A.

COAL PREPARATION—INTERNATIONAL STANDARDS MEETING

Coal preparation—washing, sieving and grading—is of direct importance to all producers and users of coal, and because coal is a commodity in which there is a significant export trade, it is obviously desirable that there should be international agreement on coal-preparation terminology and the expression of the performance of plant. For this purpose, the solid mineral fuels committee (ISO/TC 27) of the International Organisation for Standardisation (ISO) set up a special sub-committee to evolve an agreed terminology which could be followed internationally in coal preparation and related matters. This sub-committee recently held its first meeting at British Standards House in London. The chair was taken by Mr. D. Hicks, Director of Scientific Control at the National Coal Board, and delegates were present from nine countries, representing mining and research interests, as well as manufacturers of the engineering equipment used in coal preparation. Delegates achieved a large measure of agreement on a proposed international glossary of terms and definitions relating to coal preparation procedures. The meeting also discussed methods of expressing the results of coal preparation tests and of assessing performance of the techniques and equipment used for these tests. Here, too, the delegates were agreed on the essential principles. As a result of the sub-committee's work it is hoped that in due course ISO will publish recommendations both on terminology and test procedures which can be followed by all the countries concerned.

SMOKE CONTROL AREA

Orders for the creation of smoke control under the Clean Air Act of 1956 have been confirmed for Bolton and Denton in Lancashire; Hayes and Harlington in Middlesex; Osset in Yorkshire, and West Bromwich in Staffordshire. These orders cover a total area of some 380 acres and include 920 buildings. They come into operation during 1958, and with the exception of West Bromwich, no objections to any of the orders were received. The only other order which has been confirmed under the Act dealt with the city centre of Liverpool. The objections received in the case of the order in connection with the town centre of West Bromwich were from householders and were heard at a public inquiry. The principal objections were that the smoke nuisance from industries and railways should be reduced before householders were required to burn smokeless fuel, and that coke fumes in houses suffering from down-draught were dangerous to health. In announcing the decision to confirm the order, the Minister of Housing and Local Government stated that domestic chimneys were as much a contributory cause of smoke pollution as industrial chimneys. Dark smoke emitted from industrial establishments would be reduced when the Clean Air Act came into operation. There was no question of coke fumes being more harmful than those from coal.

Pyrmont "B"—an outstanding Australian Power Station

THE construction of the 200-MW Pyrmont "B" power station, Sydney, of the New South Wales Electricity Commission, was decided upon by the Sydney County Council, just prior to the outbreak of the Second World War. The general design of the station and of the plant to be installed therein was proceeded with, although war-time restrictions held up construction. But at the close of hostilities, the acute shortage of generating plant made it imperative that the actual work of construction should be commenced at once. Work began on the site in 1945, and the first part of the station was commissioned in July, 1952 with the first boiler/turbo-alternator set. The second unit set was commissioned in 1953, the third in 1954 and the fourth in July, 1955.

Pyrmont "B" is located within a mile of the centre of the city of Sydney, and it is constructed upon a six-acre site on the western side of Darling Harbour, in close proximity to the quays used by ocean-going liners. On account of the somewhat limited extent of the site area available in such a congested part of the city area, the layout of the station was designed to conform to a "vertical" plan. The station is of more than ordinary interest, in that it contains the first relatively high-pressure power plant to be placed in service in Australia, apart from the high-pressure superposed installation at the Balmain power station which is also in the Sydney area; (see *Engineering and Boiler House Review*, August, 1948). The station main buildings are of steel frame construction with brick walls, the main structure being about 160-ft. high. The tops of the self-supporting steel chimneys are 350-ft. above ground level.

Pyrmont was operated as a base-load station, as it has a fairly high overall efficiency, and is situated near the centre of gravity of the electrical load of the city of Sydney. It is linked with four other stations in the Sydney area—Bunnerong, White Bay, Ultimo and Balmain—and with the interconnected systems of the New South Wales Electricity Commission which supplies 95 per cent. of all the power consumed in the State. The nature of the electrical load has, however, changed completely during the five years since Pyrmont was commissioned. It can now no longer operate as a constant-load station, fulfilling the original purpose for which it was designed, but must take its share of the violent load fluctuations due to numerous heavy industrial demands such as that for the steel rolling mills at Port Kembla, to mention only one of the industries which have been connected to the Commission's network during recent years.

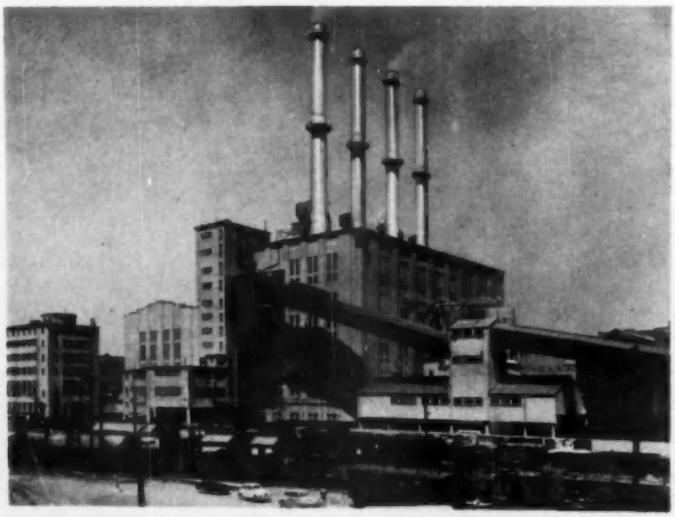
As an indication of the performance of the Pyrmont station, the following (latest published) figures of comparison showing operating results for the past two years are of interest.

	1955	1956
Units generated (million, ...	1,196.663	1,329.849
Overall station efficiency (on units-sent-out basis) (per cent.) ..	28.25	27.56

Coal-handling plant

The annual coal consumption by the boiler plant in the station is approximately 623,000 tons, the calorific value being 10,843 B.Th.U./lb., 29 per cent. volatile and 12 per cent. moisture. The amount of oil consumed per annum for lighting-up purposes, etc., is 511 tons—the calorific value of the oil being 19,440 B.Th.U./lb.

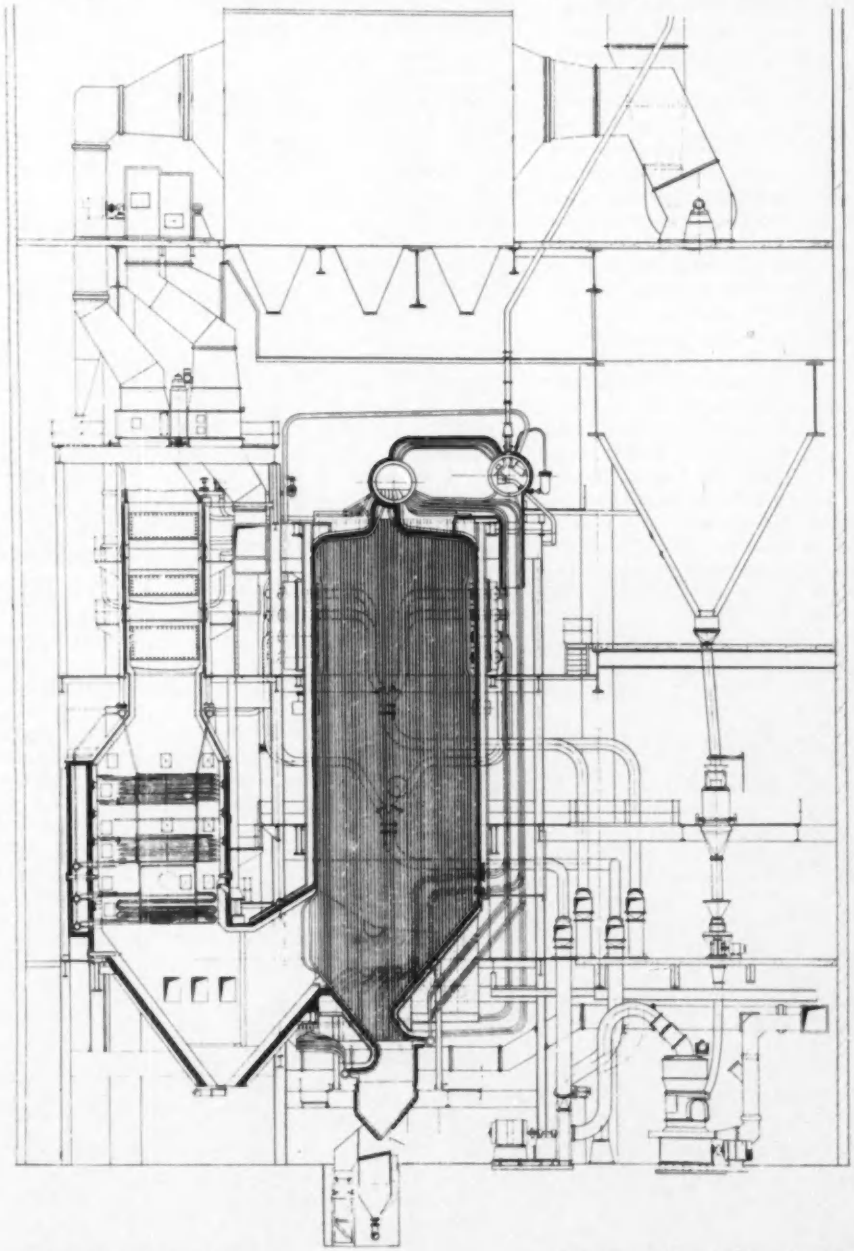
Delivery of coal supplies to the station by sea could not, unfortunately, be arranged owing to certain legal and economic considerations. Instead, it is unloaded from colliers at a dock approximately half-a-mile distant, and transported to Pyrmont by road vehicles. It is discharged from the vehicles by gravity, and passes thence by belt conveyors to a 3,000-ton capacity coal-bunker in the boiler-house. Provision is made also for delivering coal to the station by rail, in which case it is discharged from the railway wagons by gravity, or, alternatively, by two grab-cranes having a



The 200-MW Pyrmont "B" power station which has now been completed is located within one mile of the centre of the City of Sydney, N.S.W.

combined capacity of 160 tons/hr. Coal from the storage area at the station is reclaimed by bulldozer, for transfer to the conveyors which feed the boiler bunkers. In order to prevent emission of coal dust into the boiler-house, the space above the bunker is sealed-off from the rest of the building.

result of the adoption of unit system—a feature new to Australian practice, but in addition, the steam conditions were considerably higher than advanced usage outside Europe and U.S.A. The four boiler units which were designed and supplied by International Combustion (Australia) Ltd., were at the time of their construction the



Sectional outline arrangement of one of the 430,000 lb./hr. 'Lopulco' Radiant boilers which generate steam at a pressure of 1,280 lb./sq. in., and a temperature of 950 deg. F. These boilers were supplied by International Combustion (Australia) Ltd.).

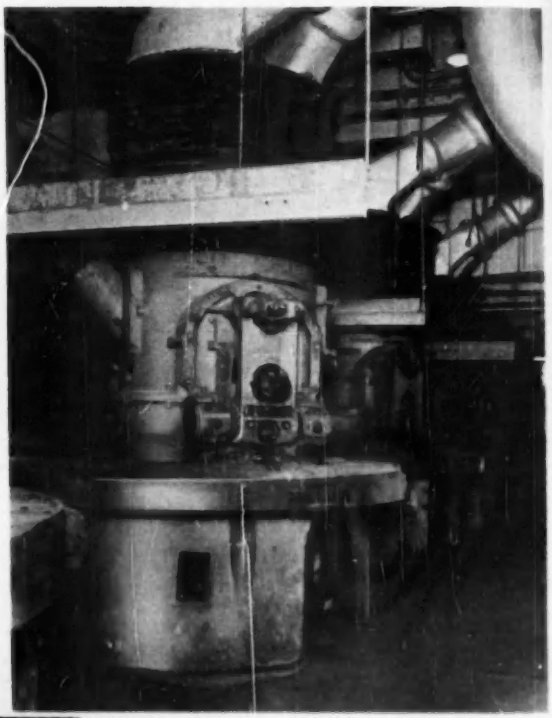
Steam-generating plant

The design of the steam generating plant at Pyrmont represented at the time of its conception, a major advance on anything attempted in the Southern Hemisphere. Not only were the steam generators of large size as a largest radiant boilers in the Commonwealth. Each boiler has an m.c.r. of 430,000 lb./hr., the steam pressure at the superheater outlet being 1,280 lb./sq. in. and steam temperature 950 deg. F.

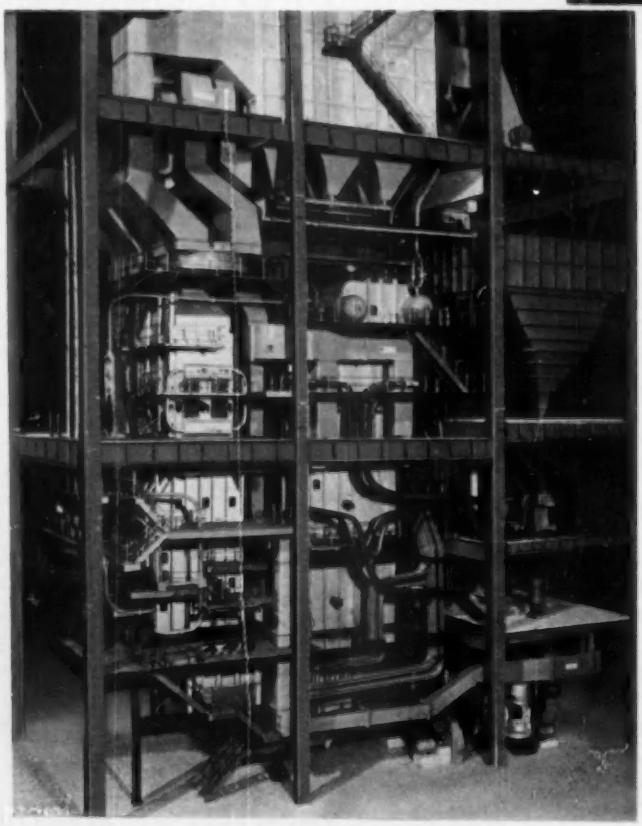
A peculiar feature included in the design was the adop-

tion of downward gas-flow, with tilting corner burners through which pulverised-fuel is fired on the tangential system. The products of combustion of each boiler descend through the furnace and ascend through the superheater, economiser and regenerative air-heater sections to a roof-mounted electrostatic-precipitator, and then to self-supporting steel chimneys, an arrangement which made possible this installation of such large boiler units on a site very restricted in area.

The coal-milling plant comprises four Lopulco L.M.12 mills for each of two of the boilers, and four Raymond Bowl mills for each of the other two. Three mills are of sufficient capacity to maintain full load on each boiler, each mill having an outlet to each of the four corners of the furnace so that symmetrical firing conditions are maintained regardless of the number of mills in service. Coal is extracted from the mills and discharged to the burners by K.B. 16/52 exhauster fans, which were made and supplied by Keith Blackman Ltd. A considerable increase in the life of the mill grinding components has been achieved by using Ni-hard with a Brinell of 650 for mill rolls and tables and exhauster fans. The tilting of the burners can be employed to manually control superheat temperature, but automatic superheat temperature control is provided in the form of two non-contact type MeLeSco de-superheaters located between the primary and secondary sections of the superheater. Normally, satisfactory control of steam temperature is obtained without resorting to the tilting of the burners. The dimensions of the furnace of each boiler are



(Above). Four Lopulco L.M.12 pulverising mills are provided for each of two of the boilers and four Raymond Bowl mills for each of the other two.



(Left). Model of one of the International Combustion Ltd. 430,000 lb./hr. Lopulco boilers at Pyrmont "B."

26-ft. wide by 20-ft. deep by 52-ft. high, it is completely lined with bare finned tubes and contains a volume of 29,300-cu. ft., giving a liberal rating of approximately 19,000 B.Th.U./cu. ft./hr. at m.c.r. It appears that some doubt arose at the time downward firing was proposed for the Pyrmont boilers as to whether the coarser fuel particles would settle out quicker, and therefore be less completely burnt. But the actual combustible in the ash proved in the event to be no greater than for an upwardly-fired furnace.

Two forced-draught and two induced-draught fans supplied by James Howden & Co. Ltd., are provided for each boiler.

The F.D. fans are designed to deal with a volume of 72,500 cu. ft./min. of air at a static pressure of 6.1-in. w.g. and at a temperature of 80 deg. F. These fans are driven by 111 h.p. motors at a speed of 730 r.p.m. The I.D. fans have a capacity of 133,000 cu. ft./min., the design static pressure being 10.6-in. n.g. and temperature 322 deg. F. They are driven by 418 h.p. motors at a speed of 730 r.p.m.

Single-stage air-heating is adopted, the forced-draught fans drawing hot air from the top of the boiler house thereby assisting ventilation. The electrostatic-precipitators are arranged

on the fan floor in this very compact installation.

The economiser installed with each boiler is of the 'Senior' welded type, and was supplied by Senior Economisers Ltd. It has a heating surface of 27,936 sq. ft., arranged 16 elements wide by 20 high, in two nests, with a length over heating surface of 24-ft. 6-in. The gases flow upwards through the economiser, and the water is fed downwards through ten rows in contraflow, and upwards through the bottom ten rows in parallel flow. The temperature of the gases entering is 1,100 deg. F., the gas leaving temperature 628 deg. F., the feed inlet 400 deg. F., and water outlet 524 deg. F. The heating surface is made up of cold-drawn steel tubes on which are shrunk cast-iron sleeves of the familiar H formation, providing straight gas-passages. All pressure joints are butt-welded.

Two CXZ.20 Howden-Ljungström air-preheaters, made and supplied by James Howden & Co. Ltd., are provided for each boiler. These each have a heating surface of 26,700-sq. ft., and are designed to reduce the flue-gas temperature from 638 to 320 deg. F., and pre-heating the air from 80 deg. F. at maximum boiler loading. Air by-passes are fitted integral with the pre-heaters to allow by-passing of up to 40 per cent. of the air.

Superheaters

The superheaters are of the MeLeSco type manufactured by The Superheater Co. Ltd. Three banks of elements are installed in the second pass of the boiler, each bank horizontally positioned, there being a total heating surface of 19,690-sq. ft. Of this total 15,770-sq. ft. are installed in the primary section, and 3,920-sq. ft. in the secondary. The secondary heating surface is positioned in the lowermost bank, the elements being pitched at 6-in. across the boiler width, whilst the primary elements are ranged at 3-in. pitch, these spacings being maintained by heat-resisting spacer castings across the boiler. Between the primary and secondary superheaters, twin-surface type de-superheaters are installed to enable the steam temperature to be maintained at loads down to 60 per cent. of c.m.r., that is, down to an evaporation rate of 258,000 lb./hr. There is additional coarse control of superheat available by manual adjustment of the tilting burners. The whole lay-out of piping connections to the de-superheaters is symmetrically arranged, and there are also double saturated steam inlet headers from which the whole of the superheater is supported. Heat-resisting steel bands are fitted to the primary elements, whilst the individual tubes of the secondary elements are spaced by means of heat-resisting steel cast slip-spacers welded to the tubes. All joints between elements and headers are of the strength welded type, each header being provided with short stub tubes to which the elements are welded *in situ*.

Boiler mountings and fittings

The boiler mountings are mostly of Hopkinsons Ltd. manufacture, and include torsion-bar safety-valves (including electrically-assisted units) safety-valve silencers, external alarms, water-gauges, combined stop and non-return valves, Hopkinson-Ferranti valves, electric valve controls, etc. Hopkinsons Ltd. also supplied the turbine stop-valves and control desks. Feedwater control is maintained by Copes two-element flowmatic feedwater regulators supplied by Copes Regulators Ltd.

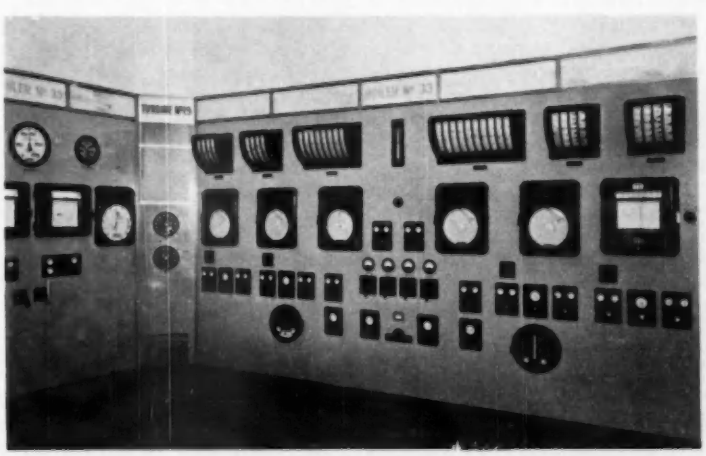
Automatic boiler control equipment

Plant operation is carried out from two centralised air-conditioned control rooms each accommodating all instrumentation and control equipment associated with two boiler turbine sets.

The complete automatic boiler control equipment was supplied by Bailey Meters & Controls Ltd., and it enables the load requirements to be followed automatically with the effective adjustable range of the ancillaries whilst maintaining optimum combustion conditions throughout all variations of load. Load-changes beyond the range of the number of mills in service can be catered for manually by shutting down or bringing into service mill groups as necessary, and full instrumentation is provided to enable the operators to carry out these duties.

The Bailey air-operated control system is utilised, and is initiated by the measurement of steam pressure at the turbine inlet stop-valve as the index of load requirements. With any deviation from pressure set point, a signal is transmitted from the master controller in the direction and proportional to the rate of change to effect an immediate corrective adjustment in the fuel and air supply to the boiler. Reset action is applied to this signal to enable the load change to be followed until stability is regained.

The fuel supply is varied in quantity by conversion of the master signal change to a positional movement of the control drives connected to the coal feeder and mill-exhauster. The temperature of the cold-air mixture carried to the burners by the exhausters is regulated by adjustment to the cold-air inlet dampers. Coincident with a change in fuel supply, the master signal initiates variations to the air supply for combustion and extraction of the products by combustion by appropriate



One of the boiler/turbine control panels. The complete automatic boiler control equipment and instrumentation was supplied by Bailey Meters & Controls Limited.

adjustment of the forced-draught and induced-draught fan controls. In order to maintain efficient combustion a continuous measurement of the quantity of air supplied for combustion is obtained and related to a measurement of the rate of steam evaporation at the correct operating conditions. This relationship has been calibrated during combustion tests to provide coincidence of indication when the desired total air at any load value is flowing. Any deviation from this correct condition causes a signal to be transmitted to the forced-draught fans to readjust of the induced-draught fan output to maintain the correct balanced draught condition in the furnace. Adequate instrument equipment caters for the indication and/or recording of draught, pressures, temperatures, etc., as necessary for functional operation; collective and convenient grouping of all instruments on the control panels has been achieved.

Feed- and boiler-water treatment

The co-ordinated phosphate pH method of boiler-water treatment is used, the chemicals being added by slug dosing direct to the feed drum. At present, the feedwater is only mechanically de-aerated and not chemically treated. However, proportioning pumps for continuous chemical dosage are being installed and will be in service in the near future, when slug dosing to the boiler drum will be discontinued. Boiler-water conditions are maintained as follows :—

Phosphate as PO_4	60-120 p.p.m.
„ pH	10.7-11.0
"P"	3.0-5.0
Sodium sulphite	2-5 p.p.m.
Silica (maximum)	5 p.p.m.
Total dissolved solids (maximum)	300 p.p.m.

Complete analysis of the boiler-water is carried out daily and the conductivity and dissolved oxygen content of condensate and feedwater are checked. The dissolved oxygen in the feedwater is maintained below 0.005 MI/litre.

Starting-up procedure, including interlocks

Supervisory flame-indicators are provided in the plant control room; when starting up a boiler, these are by-passed, electrically, the starting sequence being governed by electrical interlocks. Fifty-five seconds after the first F.D. fan has been put into service, operation of a combustion group master-switch makes supply available to the flame indicators which are then by-passed, making supply available to the ignition oil-pumps, exhauster, mills, and feeders, which are started manually in the order mentioned. Four oil-torches are normally used to establish ignition, following which the pulverised fuel equipment is brought into service, in the above order, the flame indicators being brought into normal operation. Changeover to pulverised-fuel-firing alone results when two or more mill groups are in service, it being necessary to have at least two mills in service before the ignition oil can be shut off. Two oil-torches are automatically inserted when the number of raw-coal feeders in service is reduced below two, there being a time-delay of 5 sec. between the stopping of the coal feeder and the starting of the ignition oil pumps. In the event of complete loss of ignition, the flame indicators cause the oil-torches to be "locked out" until the boiler is purged.

The firing-rate when steam pressure is being raised is governed by :—(a) a maximum increase of 150 deg. F. per hour of the saturated steam temperature. (b) a maximum temperature-difference of 100 deg. F. between the steam and water sides of the steam drum. (c) the temperature of the superheater tubes measured in the last pass, the maximum being :—

Primary outlet tubes (deg. F.)	970
Secondary inlet tubes („ „)	970
Secondary outlet tubes („ „)	1,020

It normally takes $2\frac{3}{4}$ hours to raise steam pressure from zero to the usual operating figure. Soot-blowing is carried out automatically at the instigation of the operator, in accordance with observations of the metal temperatures in various parts of the boiler.

Ash-handling plant

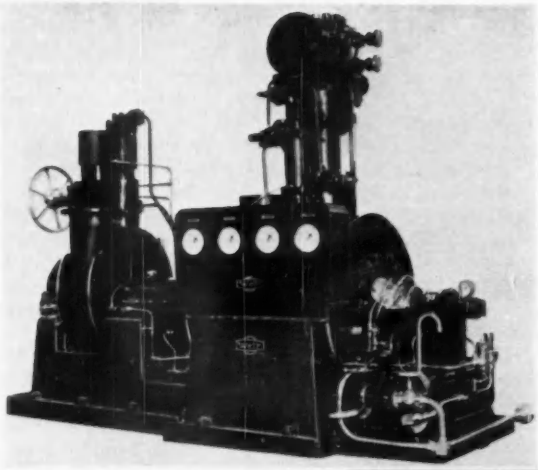
Pneumatic equipment for the conveyance and disposal of ash from the boiler hoppers, and dust from the precipitators, the chimney hoppers and the other collecting points was suppied by B.V.C. Industrial Constructions Ltd. (now John Thompson Industrial Constructions Ltd.). The ash and dust is discharged into two steel storage containers which have a combined capacity of 450 tons. The larger particles of ash pass through crushers before entering the peumatic conveyor system. The mixture of dust and ash is fed from the storage containers into rotating conditioning conveyors where it is "damped," and is then passed to road vehicles for transport to local disposal sites. In addition, provision is made for discharge of dust into barges at what is known as Blackwattle. Bay, for disposal at a distance of seven miles out at sea. In each 24 hours when the boilers are operating at maximum rating, some 550 tons of ash and flue dust are collected in the furnace hoppers, economiser hoppers and electrostatic precipitator dust-hoppers. Remote control equipment, centralised in panels sited at convenient positions for operation of the loading valves and the other various components of the B.V.C. ash and flue dust plant, eliminate to a great extent the time spent travelling to and fro betweem the boiler units, precipitators, etc.

Boiler availability

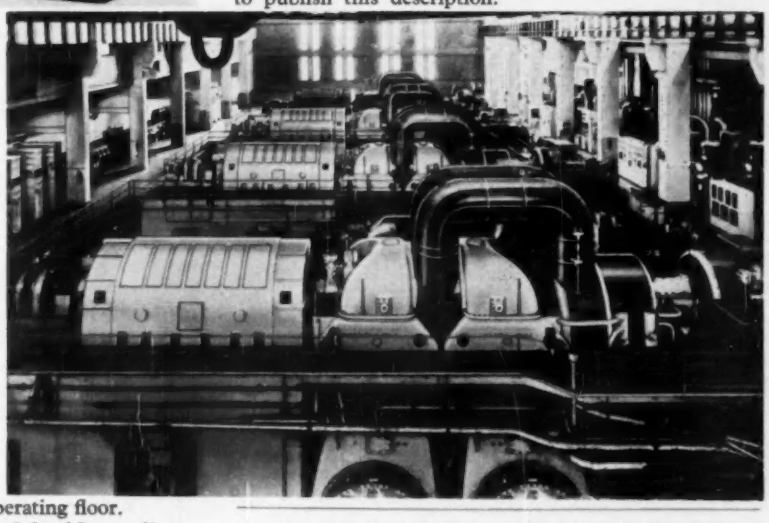
The boilers are shut down every 18 months for compulsory inspection and maintenance requirements. It is stated that there has been no trouble with corrosion of the air-heaters or boiler heating surfaces. Outstanding availability has been confirmed during the early years of operation; the average percentage availability for the first four years being—1953, 94 per cent. (for two boilers); 1954, 94 per cent. (two boilers); 1955, 95.7 per cent. (three boilers); 1956, 96.3 per cent. (for the complete installation of four boilers).

Turbo-alternator plant

The four 50-MW 3,000 r.p.m. turbo-alternator sets were supplied by Metropolitan-Vickers Electrical Co. Ltd. Each turbine has an h.p., i.p. and l.p. cylinder, and is fitted with twin double-flow condensers. The alternators are wound for 0.90 p.f. and 33,000-V generation. Five stages of feed-heating, including a contact-type deaerator, are employed in the feed-heating system, the final feed temperature being 400 deg. F. Turbine supervisory equipment is provided to enhance the safe starting-up and shutting down of the turbines. This equipment indicates and records turbine rotor position



(Above). One of two G. & J. Weir Ltd. multi-stage turbine-driven boiler feed pumps, each of 500,000 lb./hr. capacity at a discharge pressure of 1,700 lb./sq. in.



(Right). The turbine room showing the four 50-MW turbo-alternators which were supplied by Metropolitan-Vickers Electrical Co. Ltd.

relative to the casing, rotor eccentricity and bearing vibration. It is located on the turbine operating floor.

The condensers were manufactured for Metropolitan-Vickers by Thompsons (Castlemaine). They are cooled by sea-water pumped from Sydney Harbour at a rate of 37,400 gal./min. per pair of circulating-water pumps. The intake conduit is 1,625-ft. long and the outlet conduit 630-ft. long, both conduits being of rectangular section. Vertical-type travelling screens located in the inlet conduit adjacent to the turbine house, collect floating weed and other debris from the cooling water.

There are six Mather & Platt 7-in./9-in. seven-chamber high-speed "Plurovane" boiler feed pumps, each designed to deliver 500,000 lb./hr. of feedwater at a temperature of 250 deg. F., against a head of 1,600 lb./sq. in. Each pump is driven by a Mather & Platt 1,600 h.p., 5,000-volt, 2,970 r.p.m. squirrel-cage motor. The motors are direct-on started with low starting current. In addition, there are two G. & J. Weir multi-stage, turbine-driven boiler feed pumps. These are of the four-stage type, embodying relay-operated by-pass, and automatic starting equipment. Each pump is capable of delivering 500,000 lb./hr. at a discharge pressure of 1,700 lb./sq. in. Steam is supplied to the driving turbine at a pressure of 1,150 lb./sq. in.

Chlorination plant supplied by Wallace & Tiernan Ltd. is provided for treatment of the cooling water by combating minute algae in the supply to the condensers, and to prevent the formation of marine growths on the walls of the intake conduit and pump pit. The chlorination plant is arranged to operate under automatic programmed control, the cycle of chlorine release being for 5 to 15 min. duration every 3 to 4 hr. This is sufficient to produce a residual concentration of chlorine of the order of 0.5 p.p.m. As the chlorination control equipment is located in the station buildings, it was necessary to pump the chlorinated liquid to the entrance of the intake conduit; this was done through plastic tubing laid along the floor of the conduit—the tubing being encased in concrete to provide effective protection.

In conclusion we should like to record our acknowledgments to the Electricity Commission of New South Wales for providing some of the technical particulars and details of operating procedure, and also for permission to publish this description.

ORGANISATION OF A.E.A. INDUSTRIAL ESTABLISHMENTS

As a result of the recent mishap at Windscale the Government appointed a committee under the chairmanship of Sir Alexander Fleck to examine and report upon certain aspects of the Atomic Energy Authority's organisation. The first of the committee's three reports, published recently as a White Paper (Cmd. 338, H.M. Stationery Office, 2s.), states that within the authority's industrial group there is a shortage of technical staff which has imposed great strain upon the group's resources. Stating that the primary tasks of the group are to ensure that plant is safely and efficiently operated and that the first stations in the nuclear power programme are so designed and operated as to ensure maximum efficiency and safety, the committee considers that it may be necessary for the authority to concentrate development work on few projects. Particular attention is drawn to the need for the utmost care in respect of the Dounreay fast reactor; it is recommended that a new post of director of that establishment should be created. Another recommendation is that a separate works general manager should be appointed for Chapelcross.

Surveying conditions which may be retarding recruitment of technical staff by the authority, the committee criticises the methods of assessing salaries. Although it recommends a number of alterations in details of the organisation, the committee thinks that there should be no major changes; the essential unity of the industrial group should be maintained.

The Second Pulverised-Fuel Conference

The second pulverised-fuel conference organised by the Institute of Fuel, and held in London on November 27th and 28th, reviewed progress made since the earlier conference which was held at Harrogate in 1947. The subject was dealt with under four headings, the general position as to the availability of fuels in this country being first summarised. The results of fundamental and practical research were then reviewed, followed by a consideration of practice, first in this country and then overseas, including Germany, France and Australia. Among the outstanding points which emerged from the papers presented and the discussions thereon, was the part being played by dry and wet-bottom type furnaces respectively. The former were used entirely in France and, until the recent introduction of the cyclone-fired furnace, also in this country. In Germany, wet-bottom furnaces are extensively used. The disposal of fly-ash produced from dry-bottom furnaces is a growing problem in this country, and possibly favours an increase in the use of cyclone-fired furnaces. Nevertheless, great efforts are being made to develop markets for fly-ash, which can be regarded as a by-product of the power generating industry. In Australia the difficulties associated with the use of brown coal in pulverised form have been largely overcome. Progress in the prevention of deposits and corrosion in boilers was reviewed, and the opinion expressed that with British coals, the difficulties arising from these can be overcome despite the growth in size of boiler units, and the extent to which pressures and temperatures have increased during recent years.

THE conference was opened by Sir Josiah Eccles, Deputy-Chairman of the Electricity Council, who, in his opening address, said that over half the coal used in central power stations throughout this country was now burned in the form of pulverised fuel. He recalled that p.f. was first used on an extensive scale in 1935 at the Nechells power station, and that by 1947 it accounted for 25 per cent. of the fuel used in boilers installed with electrical power generating plant. Of the coal used at the present time, 70 per cent. is in the form of uncleaned smalls with an ash content of between 16 and 40 per cent., and this is blended before burning. Combustion resulting from p.f. firing is more rapid and efficient than is possible with a stoker-fired plant for which the maximum boiler output is 250,000 lb./hr. The unit system of power generating plant obviously requires larger boilers than this, and such installations use either p.f. or (in the future) cyclone furnaces.

Sir Josiah compared "dry" and "wet" bottom furnaces, pointing out that in the former, 75-85 per cent. of the ash passes through the boiler and has to be trapped. It could burn almost any type of coal. In wet-bottom furnaces 50-60 per cent. of the ash was removed as fused slag, some 40 per cent. passing on through the boiler passes. This type of firing was sensitive to ash properties, and boiler deposit problems arose if the chlorine content of the coal exceeded 0.66 per cent. With cyclone-fired furnaces—tangentially-fired, up to 85 per cent. of the ash results as slag, only the remaining 15 per cent. passing through the boiler. He referred to results so far obtained on the cyclone furnaces as being most promising.

The recovery and disposal of fly-ash presented considerable problems. Cyclone separators in combination with electrostatic-precipitators could remove 97.5 per cent. of solids in the gas, and this figure rose to 99 per cent. under test conditions. The disposal of 3.5 million tons of fly-ash from boiler plants in this country was increasingly difficult in view of the fact that transport over lengthy distances is very expensive.

Finally, Sir Josiah mentioned some of the problems that would have to be solved in the future. These included the handling and preparation of fuel; the provision of larger and quieter mills; and the use of additives to check the extent of boiler fouling.

The fuel supply background

Dr. G. H. Daniel (Ministry of Power) in the opening paper (1) of the conference, drew attention to the fact that whereas during the last decade our total coal consumption rose from 191 to 220 million tons per annum, the only groups which increased their demand were the power stations and the carbonising industries. The latter required coals with special properties, but the power stations took an additional 16 million tons per annum of small, mainly uncleaned coal. This fact enabled the Coal Board to balance supply and demand for various grades of coal, and to avoid the costly process of cleaning this large amount of smalls. As regards the next decade, power stations will, it is anticipated, take increased amounts of fuel oil, and nuclear power stations will make their contribution to our energy supplies at the expense of small coal. Thus, most of the additional supplies of this grade resulting from increased output and the greater breakage of coal due to the use of modern mining methods will have to find an outlet in industrial and commercial markets. Dr. Daniel further considered

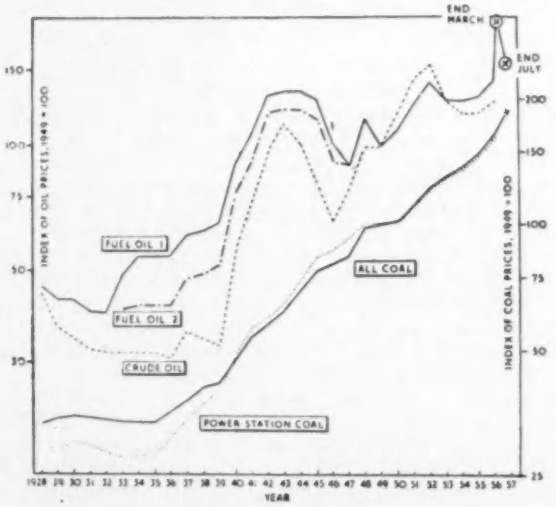


Fig. 1. Changes in the price of coal and oil between 1928 and July, 1957.

KEY: 1. The prices used are:—Fuel oil—medium grade, delivered in inner zone—(1) Including tax. (2) Excluding tax. Crude oil—average c.i.f. import value. Power-station coal—the cost of coal as fired at power stations corrected for changes in the calorific value of the coal. All coal—an estimated delivered price obtained by combining the index of average pithead proceeds with an index of railway freight rates. 2. The scales are logarithmic and the oil and coal graphs are so spaced that they would coincide if the price of fuel oil was 1.7 times that of coal.

the quality of the small coal likely to be available, and pointed out that ash, fines, moisture and sulphur content were tending to rise, and that unless such coal could be used by industry, it would have to be cleaned at a very considerable cost. Such smalls as were already used by industry were mainly taken by the larger undertakings, probably because more expensive plant was required to burn these fuels, and general operation and maintenance were more costly and difficult. In this connection, a point to be remembered was that in these larger plants, coal was being replaced by oil. Finally, on this aspect of the subject, it was important that inferior coals should be used only in appliances designed to burn them with the minimum of smoke, grit and dust.

Dr. Daniel also discussed the future trends of coal and oil prices, and considered that an upward tendency would continue in each case, but the relationship between them would be difficult to forecast. Curves showing changes in the prices of coal and oil between 1928 and 1957 are reproduced in Fig. 1.

During the discussion on this paper, Dr. A. Parker (lately director of the Fuel Research Station, D.S.I.R.) said that something like 10 million tons of smalls would be available for disposal, and that power stations would take less. The users of smalls would find dust extraction expensive, and although briquetting was an answer, this could prove very costly. If, therefore, smalls could not compete in price with oil, the price of the former might have to be reduced with a corresponding rise in the price of large coal.

Fundamental research work

The next group of papers dealt with research work, both practical and fundamental. Two papers by authors connected with Sheffield University discussed the burning times of coal particles in a p.f. furnace, and the distribution of residence times in a model p.f. boiler. In the first of these Mr. R. H. Essenhigh (2) compared burning times measured in the laboratory with those obtained in the Ijmuiden experimental furnace. The importance of this question lies in the necessity of matching burning and residence times when designing a boiler. If this was not done, the flames might be too long and result in too high an exit temperature, thereby causing damage to superheaters. On the other hand, they may be too short, with the result that combustion space is wasted. The equation derived by Essenhigh, takes into account the time required to ignite the coal particles, to burn the volatiles and finally to burn the residues. A reasonable agreement was obtained in the case of the residues, but the burning times of the volatiles in the furnace were considerably greater than those predicted by the equation. Nevertheless, it is put forward as a semi-empirical formula which may be of some use to furnace and boiler designers.

The distribution of residence times in a model p.f. boiler, using lycopodium powder as a tracer, was determined by T. J. Peirce and M. W. Thring (3). The powder was injected through one of the burners and metered at the combustion chamber outlet by allowing it to interrupt a beam of light falling on a photo-cell. The results indicated the extent to which particles pass straight through, or circulate within the combustion chamber.

A third paper in this series, by M. W. Thring and E. H. Hubbard (4) described some results obtained at Ijmuiden on radiation from certain flames formed by burning pulverised-fuel. It was concluded that in general, the emissivity of these p.f. flames was somewhat over 0.8 and that the emissivity variations, as between one flame and another, were not great. The main effects of the variables were upon the rate of combustion and the residual carbon, and upon the radiant temperatures of the flame. Primary air was the most important variable, and fineness of coal the next most important.

In the discussion following the presentation of these contributions, Dr. Gumz remarked that the process of combustion was complicated, and the formulae simplified. Equations deduced from a model furnace never matched up with practical conditions. The validity of a new empirical formula was not proved for other applications. Practical data usually satisfied the designer, and the value of work of the kind described in these papers lay in a better understanding of combustion processes.

Practical research work

The next group of papers dealt with research from a more practical aspect, being concerned with the distribution of p.f. and air to the burners of a power station boiler plant (5), the effect of the dust burden on Pitot-static readings (6), probe equipment for furnace investigations in power station boiler furnaces (7), pulverised-fuel and boiler availability (8), and sampling and size analysis of p.f. and fly-ash (9).

The first of these contributions, by G. W. Hayward (5), described tests on a 320,000 lb./hr. boiler with 12 corner burners. It was found that the air/fuel mixture varied considerably from burner to burner, thus causing unbalance in combustion conditions. This was traced to unsatisfactory division at the primary and secondary riffles, and these were modified to produce a more uniform distribution.

J. Dalmon and H. J. Lowe (6) showed that as far as Pitot-static measurements are concerned, a mixture of coal dust and air behaves as a homogeneous gas of the same mean density.

M. E. Peplow (7) described probe equipment which has been found satisfactory for the measurement in a boiler furnace of gas temperature, gas analysis, gas velocity, particle analysis, heat transfer rates, heat content of gases, and ash deposition. The development of further probe equipment to provide other data was still required. For example, some measurements had already been made of gas electrical conductivity, which depended on the temperature and alkali content of the gas.

With these papers may be included that by T. H. Hughes (9) dealing with the sampling and size analysis of p.f. and fly-ash. This paper described the development of new apparatus and methods, and although, by the use of these, no spectacular discoveries could be reported, there had been a tendency to simplification of existing techniques, and the development of new and somewhat more elaborate apparatus which, nevertheless, enabled results to be obtained by less highly skilled operators. The various methods and apparatus used for p.f. sampling, the exploration of velocity in a fuel pipe, and for the use of measuring devices to explore mass distribution and particle size analysis are described.

In the discussion on this group of papers, Mr. Dransfield said that in practice, no p.f. plant had an equal fuel/air distribution, but that the papers were very useful

in that they presented a typical picture. Mr. R. F. Davis pointed out that corner firing did not necessarily ensure equality between burner and burner, and that it was difficult to equalise both fuel and air. Mr. Hurley (Fuel Research Station) drew attention to the station's " chess board " pattern or multi-jet p.f. burner, which had given satisfactory fuel distribution, and which had been described as early as 1935. Other speakers suggested that bad distribution did not greatly affect efficiency, but that capital could be saved by reducing the combustion space. In general, it seemed to be the opinion that, whilst this group of papers provided new tools and presented data which threw new light on the practical combustion process, it did not replace the pool of available practical knowledge upon which designers were accustomed to draw.

Boiler availability

An outstanding contribution in the group of papers devoted to practical research was that of H. E. Crossley and E. M. Hamilton (8). This compared the present position with regard to fouling and corrosion in p.f. boilers with that reported by Crossley in 1947. At that time it was believed with some certainty that p.f. boilers were immune from these troubles, and the theory was advanced that bonded deposits were formed by the binding together of fly-ash particles with fusible alkali compounds. It was thought that the method of combustion was such that the dew point, an indication of the presence of SO_3, remained low and corrosion did not occur. During recent years, however, it had been found that p.f. boilers were not necessarily free from these troubles which had occurred in association with coals containing over 0.6 per cent. of chlorine. It had also been found that wastage of superheater tubes could occur at steam temperatures above 1,050 deg. F., especially with coals having a high sulphur content. More coals are now being mined, mainly by collieries in the East Midlands coalfields, with a chlorine content in excess of 0.6 per cent., and often with an increasing sulphur content. In general, the difficulty had been overcome by blending coals in order to lower the average chlorine content below this figure. The authors, however, were of the opinion that there was no serious menace to power plants in this country, because in general the coals produced did not contain excessive amounts of chlorine and sulphur. Various proposed methods of combating these troubles if they should occur were discussed. Blending had already been mentioned, and the recirculation of flue gases to the combustion chamber was being investigated as a means of lowering the gas temperature and lessening the danger of corrosion. The possibility of exposing coal stocks to the weather so that chlorine could be removed by rainwater was also suggested. The prevention of air-heater corrosion could be assisted by the use of certain additives such as dolomite, and it was of interest to note the tendency to revert to W. F. Harlow's theory that SO_3 formation occurred catalytically on superheater tubes above a limiting temperature, and may, therefore, be a function of the higher steam temperatures now used. Harlow had suggested that this might be controlled by coating the surfaces with a suitable non-catalytic substance. The authors, however, believed that the availability of p.f. boilers in this country would remain high, and that boiler manufacturers had successfully met the challenge presented by increasingly severe operating conditions. The tendency for superheaters to become blocked was being met by a wider spacing of the tubes and other methods. The possible effect of the new cyclone-fired, and other wet-bottom type furnaces on availability was also considered. Such furnaces considerably reduced the amount of fly-ash passing through the boiler, and so affected the ratio of this to the amount of binding material available. There was no extensive experience in this country, because the first cyclone furnace had only recently been put into commission.

Fouling of superheaters in cyclone-fired boilers had been reported from Chicago where, however, the coals used were of a high chlorine and sulphur content. Even so the rate of fouling was lower than that encountered with the same coals burned on stoker-fired boilers. The evidence available in this connection was limited and the authors considered that it would be necessary to study the chlorine and sulphur contents of the coals used before the significance of the data available could be assessed

In the discussion on this particular paper, Dr. Monkhouse described the work as an outstanding example of the practical application of research. The mechanism of boiler deposit formation was not fully understood, and as new advances in design continued, further troubles might be experienced.

Developments in Great Britain

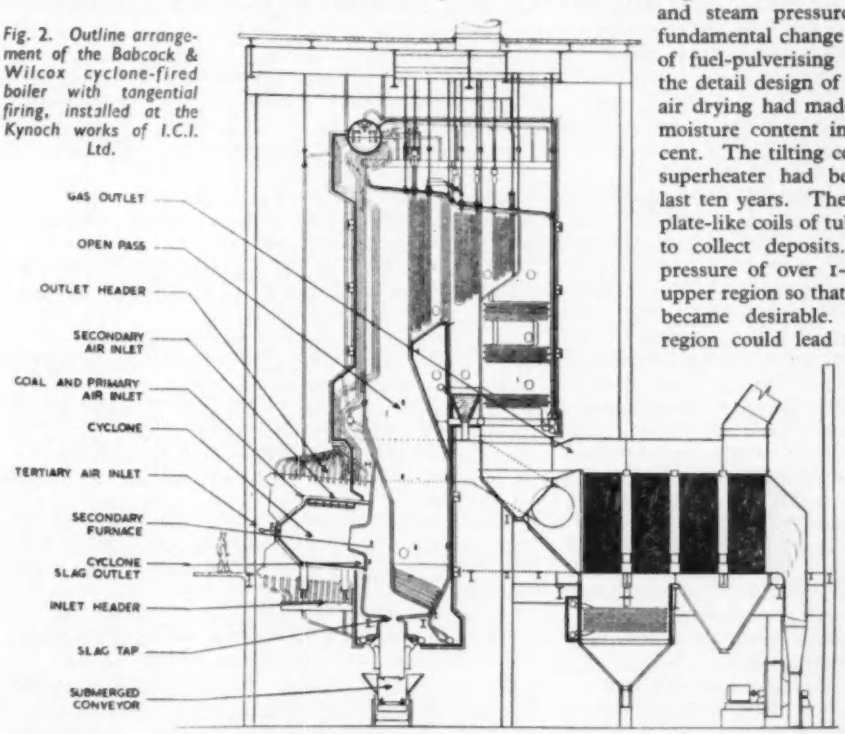
Developments in both cyclone firing and the use of low-volatile coals for p.f. were described by Mr. W. G. Marskell (10), who gave the principal advantages of cyclone firing as follows : (i) A smaller plant was required for an equal output of steam ; (ii) the amount of solids in the exit gas was only about 10 to 15 per cent. of the total ash in the coal ; (iii) the very low dust loading of the gases made possible a reduction in size, or even the elimination, of the electrostatic precipitator ; (iv) the molten ash could be easily handled ; (v) the ash could be returned to the furnace and converted into slag, with the result that there was no dust disposal problem ; (vi) the excess air required for satisfactory combustion could be reduced as low as 10 per cent. ; (vii) with multiple cyclone firing, a wider range of loading was possible without loss of efficiency.

The author then considered the properties of coals suitable for this method of firing. Much depended on ash characteristics, and the determination of ash fusion point and viscosity was not altogether satisfactory using present methods. He gave the general limits of the ash fusion point as 1,315 deg. C. in a semi-reducing atmosphere when using crushed coal fired axially, and 1,450 deg. C. for pulverised coal fired tangentially. The corresponding lower limits of volatile matter are 15 and 10 per cent. respectively. At present the only cyclone-fired installation operating in this country was at the Kynoch works of I.C.I. Ltd. (Fig. 2) and this unit had on test shown a gross efficiency of 88 per cent. A cyclone-fired plant was about to be commissioned at the Barking " C " power station of the C.E.A., and others were on order or in course of construction. The author gave as reasons, among others, for predicting a rapid expansion of this method of firing, that there was no longer a fear of serious corrosion or deposit troubles,

and that the conversion of fly-ash into slag would help to overcome a serious disposal problem. He added that it would be unwise to install cyclone firing where the available coals fell outside the limiting properties indicated by American and Continental experience.

Referring to the firing of low volatile coals in pulverised form, Mr. Marskell said that this was a field in which there had been little development during the past ten years because the supplies of such coals were restricted. For boilers above 360,000 lb./hr. using this type of fuel the so-called W-flame furnace, with opposed downshot burners, had been successfully introduced.

Fig. 2. Outline arrangement of the Babcock & Wilcox cyclone-fired boiler with tangential firing, installed at the Kynoch works of I.C.I. Ltd.



Mr. R. F. Davis (11) described developments in connection with large p.f. boilers that had taken place since the 1947 conference. He drew attention to the progressive deterioration in quality of the fuel supplied to central power stations, and to the modifications made in plant design to meet this problem, together with those arising from the continued increase in boiler size, and steam pressures and temperatures. No fundamental change had been made in methods of fuel-pulverising although improvements in the detail design of mills had been made. Hot air drying had made it possible to deal with a moisture content in the coal of up to 30 per cent. The tilting corner burner and the platen superheater had been introduced during the last ten years. The latter consisted of edge-on plate-like coils of tubes which had less tendency to collect deposits. In very tall furnaces a pressure of over 1-in. w.g. could exist in the upper region so that a pressurised type of casing became desirable. A suction in the lower region could lead to air infiltration and loss of efficiency. "Cubical expansion" construction was being adopted in some of the latest designs of boiler plant.

The five main stages in recent boiler design are shown in Table I. The latest at High Marnham has an evaporative capacity of 1,350,000 lb./hr. with pressure and temperature of 2,450 lb./sq. in. and 1,055 deg. F. respectively. The five boilers listed were described in detail in Mr. Davis's paper. At High Marnham the load was divided between two furnaces operating in parallel—one containing the superheater, and the other the re-heating surfaces. The design allows for assisted circulation. Twin furnaces had the advantage that it was possible to light up one from "cold" before reheat steam was available in the other. As a precautionary measure, gas recirculation up to 15 per cent. of the com-

TABLE I—FIVE STAGES IN BOILER DESIGN

Station	Pyrmont "B"	N. Wilford "D"	Drakelow "A"	Drakelow "B"	High Marnham
Evaporation CMR lb./hr.	430,000	320,000	515,000	860,000	1,350,000
Sup. ht. outlet pressure lb./sq. in.	1,280	625	1,550	1,600	2,450
" " " temp. ° F.	925	860	1,060	1,010	1,055
Re-heater outlet temp., ° F.	None	None	None	1,005	1,005
Circulation	Natural	Natural	Natural	Natural	Assisted
No. of drums	Two	Two	Two plus header	One	One
Downcomers	3 in. o.d. tubes	4 in. o.d. tubes	4½ in. bore pipes	10 in. bore pipes	8¾ in. bore pipes
Steam separation	Washer	Baffles	Washer	Turbo separators	Turbo separators
Furnace walls	3 in. o.d. fin tubes	3½ in. o.d. fin tubes	3 in. o.d. fin tubes (sides plain)	3 in. o.d. fin tubes	1½ in. o.d. tangent (part radiant superheater)
Secondary superheater	Horizontal drainable	Horizontal drainable	Vertical pendant	Vertical pendant Part platen	Vertical pendant Part platen
Superheat control	Bottle only	Bottle only	Tilting burners and damper	Tilting burners, sprays gas recirculation and damper on reheater	Tilting burners and sprays
Burners	Fixed adjustable	Fixed adjustable	Tilting	Tilting	Tilting

bustion products was provided for in the earlier units of this type, in order to reduce the gas temperature, if necessary, when burning high-chlorine, low ash fusion temperature coals.

Low volatile coals

B. S. Gylee and W. Lloyd Williams (12) discussed developments in the use of low volatile coals for steam-raising purposes in South Wales. In order to maintain ignition, very fine grinding of the coal was necessary—not less than 70 to 80 per cent. through 200 B.S.S.—with combustion-chamber pressures near to balance. All boilers using low or medium volatile coals in South Wales had down-shot firing. There was no apparent design trend over the last ten years which specially referred to the firing of low or medium volatile coals. Details are given of the boilers and firing equipment at Uskmouth, Carmarthen Bay, Tir John and Llynfi power stations respectively. Improved results during the past ten years have, it is suggested, been due more to improved methods of operation than to changes in design. The need to increase the refractory areas to facilitate the burning of low volatile coals was now in doubt, while the reduction in carbon loss and the enhanced efficiency produced by two-mill operation was apparent. The production of a burner having a controllable discharge velocity was suggested as a matter requiring investigation.

It was suggested during the discussion of these two papers that whereas slagging furnaces were largely used in the U.S.A. and Germany, in Britain dry-bottom furnaces had so far been used because of the variable ash characteristics of available coals. Many p.f. furnaces had no outages between the yearly shut-downs for survey. The incentive to change from one type to the other lay in reduced capital outlay and maintenance. There had been some tendency towards fouling in cyclone furnaces in the U.S.A., but this, it was understood, had been largely overcome. The addition of CaO or Fe_2O_3 as fluxes was impracticable in large plants using variable coals, whilst blending was inconvenient, and could on occasions fail to have the desired result. Fly-ash could be used for land recovery or levelling purposes if covered with some 6-in. of soil. The question of using p.f. to fire a shell-type boiler was raised, and it was claimed that this made for flexibility, high performance and the use of a wide range of coals. It promoted cleanliness and complete combustion, and was mainly trouble-free. Dr. Gumz said that although the cyclone furnace enabled a smaller plant to be used for a given output, and the amount of fly-ash was smaller, this type of ash was troublesome. It was very fine and tended to stick to furnace walls and preheaters, and to cause trouble in electrostatic-precipitators by sticking to the plates. He doubted if more than two cyclones should be used to a furnace because the distribution of the gas flow was affected as the gas was still spiralling when it entered the furnace. Dr. Crossley remarked that, as compared with the 12-15 per cent. carbon in ash as found with low volatile Welsh coals, with English bituminous coals this could be as low as 3 per cent.

The remaining papers in this group were presented by K. E. Dadswell and F. Dransfield (13), and H. W. G. Dedman and A. E. Hawkins (14). The former dealt with various problems relating to p.f. milling plant, and showed in graphical form (Fig. 3) the rapid growth of p.f. firing as compared with stoker firing, over the last ten years or so. Availability was of paramount importance with large installations, and standby plant was necessary because certain routine replacements were required whilst the boiler plant was still in operation. Maintenance costs for vertical spindle mills were given as 5d. to 10d. per ton of coal milled, and for tube mills of the order

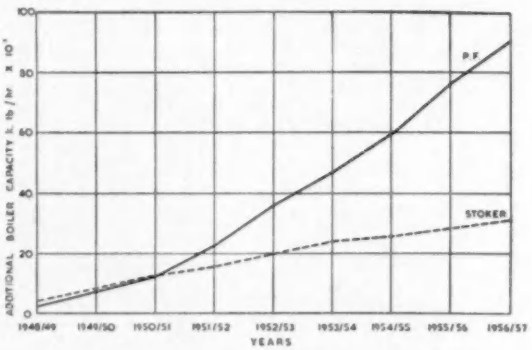


Fig. 3. Additional boiler plant capacity commissioned by the Central Electricity Authority since April, 1948.

Total capacity of stoker-fired boiler plant in commission on April 1st, 1948—107,322 k.lb./h. Total capacity of p.f. boiler plant in commission on April 1st, 1948—23,210 k.lb./h.

of 4d. per ton, excluding liner renewals, which had not yet been necessary in the particular mills under consideration. The degree of fineness of coal, the power consumption and mill chokeage were also discussed, together with the steps necessary to avoid explosions. It was suggested that more research was required, especially into the optimum size of coal "as fired," in order to avoid waste of power, and into the choking of feeders and chutes which still caused trouble.

The last paper referring to developments in this country was by Dedman and Hawkins (14), and dealt with the disposal and utilisation of fly-ash from p.f. furnaces. During the last decade the amount of fly-ash produced annually had increased from 750,000 to 3 million tons and it was expected to reach 4 million tons by 1961/62. At the present time only about 150,000 tons, some 5 per cent. of the total, was being effectively used in industrial and other processes. If such uses were not developed the disposal problem would become critical because of the difficulty of finding adequate disposal sites. This difficulty would be greatly accentuated as larger boiler units were established in inland areas. The largest amounts were likely to arise in the East Midland and Yorkshire coalfields. Suitable transport techniques were being developed, but transport for disposal over any lengthy distance would necessarily be costly. As regards utilisation, it would appear unlikely that a very close specification of fly-ash would be required, except as to carbon content, but the reputation of producing a product of uncertain properties must be avoided. The main industrial outlets would probably be in the building and civil engineering industries. It was already proving useful as an aggregate for the manufacture of bricks, concrete (both mass and re-inforced) for road construction, and as a filling material on building sites. Dumps can be made agriculturally productive if covered by a few inches of soil. The C.E.A. was actively engaged in

developing uses and markets for this material. It should be noted that one of the advantages of the cyclone and wet-bottom type furnace was that the fly-ash was converted to a fused, dense product that could be easily dealt with.

Overseas developments

Overseas developments, with particular reference to those in Australia, were described by F. H. Roberts, in a paper (15) that discussed experiences in burning pulverised brown coal in power stations in Victoria. Morwell brown coal had an average moisture content of about 62 per cent., whilst at Yallourn the average was about 66 per cent.—a figure that could rise as high as 70 per cent. Raw brown coal could be burned satisfactorily on grates in small to moderate sized boilers, but for larger plants pulverised-fuel-firing was always used. It was not necessary to grind brown coal very finely, but the drying and transportation involved difficulties. These problems had been solved by the introduction of the " unit system " of coal feed. The incoming wet coal was fed down a shaft into the pulverising mill, while the hot drying air was introduced direct to the mill. The semi-dried mill product was then conveyed up the shaft and into the furnace, the shaft acting as a simple form of classifier. At Morwell power station now being constructed, Kramer mills were being installed, and a grate in the bottom of the furnace was provided so that any oversize particles which succeeded in entering the furnace fell on to this and were burned. At Yallourn power station, mills of the K.S.G. type were used, and the system of drying shafts, mill ducts and burners was designed to be self-regulating, and to produce a pulverised-fuel of about 30 per cent. moisture at full load.

When the Yallourn plant was originally started up combustion was very unstable after the lighting-up burners had been extinguished, pulsations of rapidly increasing amplitude occurring until the main burners themselves went out. After considerable experimental work it was found that an increase of refractory material round the burners improved, but did not cure the pulsation trouble. Eventually it was found that the pulsations were dependent upon the moisture content of the raw brown coal, and occurred when this exceeded 64 per cent. To explain the effect of this amount of water, it must be remembered that all the moisture evaporated goes to dilute the air supply to the burners, and above a certain degree of dilution of the air by water vapour, ignition becomes irregular and pulsations occur. The trouble was eventually overcome by using a vertical separator in which a substantial proportion of the pulverised coal is concentrated by passing the mixture coming from the mill through a fixed set of swirling vanes, and then diverting this concentrated fuel mixture on the outer periphery to the lower burner. Thus about 85 to 90 per cent. of the coal is delivered to the lower section of the burner accompanied by only 30 per cent. of the total drying gases and coal mixture, the balance of coal and inert gas passing on to the furnace through the top burner. This apparently solved the pulsation problem. Brown coal in pulverised form had now become the principal source of fuel for power generation in Victoria.

Dr. W. Gumz's paper (16) described developments and trends in p.f. firing in Germany which had been in the direction of wet-bottom or slag-tap furnaces. Pulverised fuel now provided 50 per cent. of the steaming capacity in Germany, 46 per cent. of which was burned in dry-bottom furnaces and 54 per cent. in slagging-type furnaces. Cyclone-fired furnaces, the use of which was increasing rapidly, accounted at the present time for 2.5 per cent. of the total. In Germany the mining industry provided its own power requirements and, in order to dispose of middlings, dust and slurries, generated excess power which was fed to the public utility grids. This power generation by the mining industry was equal to about 14 per cent. of the total generated in Western Germany.

Fly-ash disposal presented a serious problem, especially in cities, and this was an important factor in bringing about the increasing use of slagging furnaces. These could be classified as (a) wet-bottom open furnaces, (b) slag-chamber closed furnaces, i.e., with a screen between the slag-chamber and the secondary cooling chamber, (c) vertical cyclone furnaces, and (d) horizontal cyclone furnaces. The slagging hopper furnace allowed slagging operating at high loads, whilst non-slagging operation during a limited period was possible in most slagging furnaces, provided the ash content of the fuel was moderate and accumulations of residues could be melted when higher loads were resumed. Practical experience with slagging furnaces showed that good combustion and efficiency could be obtained, the latter reaching 90-92 per cent. net. Carbon loss in the slag was negligible. Heat loss in liquid slag could be used partially for heating cold air before it entered the furnace. Dry-bottom furnaces had been developed to the same degree of efficiency so that the two types could be regarded as equal. Slagging furnaces would, however, be increasingly used as a means of disposing of the fly-ash problem. It had been suggested that this could also be done by sintering the fly-ash. One of the major disadvantages of the slagging-type of furnace was deposit formation, and to overcome this the specific rate of combustion should be limited. If the fly-ash disposal problem was overcome, dry-bottom furnaces could again be favoured because of easier operation and better boiler availability.

High-ash fuels in French power stations

The final paper presented to the conference, by M. Vellard (17), discussed problems arising from the use of high-ash fuels in thermal power stations in France, where dry-bottom furnaces are used to the entire exclusion of the slagging-type. This was because, to date, no great difficulty had been experienced in disposing of the fly-ash, despite the fact that some 4 million tons of low grade coal with an ash content up to 42 per cent. were burned annually. To deal with such high ash and variable coals, blending was often practised, modern power stations having as many as ten hoppers, each containing 200 to 250 tons, and each reserved for a certain quality of coal. For mixing, vibrating feed tables had so far proved the most satisfactory. Special problems of sampling were involved, and a regular schedule for deliveries was necessary. In many plants, lack of grinding capacity often resulted in a bottleneck, and limited the ash content which could be used. The standard Hardgrove test was not applicable to fine coals, and granular coals such as middlings were very heterogeneous and results depended more upon the nature

than the quantity of the inerts. The solution of the grinding problem thus consisted mainly in having plant suitable for high ash coals.

Nord and Pas-de-Calais coals had relatively high fusing ashes with an initial softening point in the region of 1,050 deg. C., and a melting point of about 1,350 deg. C. It was also considered that the loss of heat in molten slag would be appreciable. Satisfactory results had so far been obtained with dry-bottom furnaces, efficiencies of 90 per cent. net being possible with an ash content of 40 per cent. The boilers were very flexible, and it was found that the temperature of the furnace gases decreased with increasing ash content. This was of advantage in preventing the ash from sticking to, and fouling the combustion chamber, but was a disadvantage in that it was difficult to operate below one-third of the full load with coal of 42 per cent. ash, or below one-fifth with 30 per cent. ash. Availability was good and had been improved by wider tube spacing in modern boilers. This and the absence of baffles had also decreased erosion. Steam-operated soot-blowers were used to remove ash accumulations in convection banks, and the availability was of the same order as that of boilers using normal coals. Electrostatic-precipitators were used to remove dust from the gases because of the high efficiency and low pressure drop. The ash removed by the dust-collectors was usually handled by Redler conveyors, but pneumatic removal was also used. The material was, however, very abrasive, and it was essential that the plant should be perfectly air tight. Before being loaded the ash was wetted to give 15 to 30 per cent. moisture. It was often dumped with washery shale. The development of a market for this fly-ash was expected, for such purposes as concrete aggregate, road works, etc. The economic use of high-ash colliery products was also considered, and it was concluded that this could only be improved by the development of markets for the residual ash.

In the general discussion of these papers on overseas practice, the use in Ireland of peat in pulverised form was described as being similar in principle to that of brown coal. The use of brown coal in Hungary was also mentioned, the moisture content being given as of the order of 40 per cent. Special flame supporting burners were used, and preheated air was incorporated at the burner. It was suggested that an open drying circuit could be used so as to reject the wet air instead of feeding it to the furnace, and it was emphasised that the possibility of using an increasing range of fuels would probably grow with experience and development. It was also stated that the re-injection of ash to complete the burning out of carbon would increase erosion.

Summary

Dr. Parker very briefly summarised the conference proceedings. He suggested that basic research would help to make minor improvements. There were many inter-related factors, such as distribution between burners, which could bring about improvements. He put the case for the cyclone furnace as about fifty for and fifty against. With regard to the reduction of excess air to 10 per cent., as had been suggested, he thought that the semi-reducing conditions resulting would favour slagging in dry-bottom furnaces. In a mill only about 1 per cent. of the power was actually used to break up the coal, and it should be possible to improve this and reduce costs. It might be difficult otherwise to compete with brown coal which required little grinding. He raised the question as to whether the Coal Board could supply a consistent blend to individual power stations. As regards the future in Great Britain, this depended on availability and price of coal. The use of small coal was more costly in many ways, and the Coal Board might have to consider the generation of power at the mines.

List of Papers and Authors

1. "The Fuel Supply Background." G. H. Daniel, D.Phil., B.Sc., (Ministry of Power).
2. "Burning Times of Coal Particles in a P.F. Furnace." R. H. Essenhigh, M.A., (C.E.A. Research Fellow).
3. "Distribution of Residence Times in a Model of a Pulverised-Fuel Boiler." T. J. Peirce, B.Sc., (C.E.A. Research Laboratories, formerly Department of Fuel Technology and Chemical Engineering, University of Sheffield) and M. W. Thring, M.A., F.Inst.P., M.I.Chem.E., F.Inst.F., (Professor of Fuel Technology and Chemical Engineering, University of Sheffield).
4. "Radiation from Certain Pulverised-Fuel Flames." M. W. Thring, M.A., F.Inst.P., M.I.Chem.E., F.Inst.F., (Professor of Fuel Technology and Chemical Engineering, University of Sheffield. General Superintendent of the Work of the International Flame Research Foundation), and E. H. Hubbard, B.Sc., M.Inst.Gas E., M.Inst.F., A.I.M. (Principal Investigator, International Flame Research Foundation).
5. "Distribution of Fuel and Air to the Burners of a Power Station Boiler." G. W. Hayward, A.M.I.E.E., (Test Engineer, C.E.A., London Division).
6. "Effect of Dust Burden on Pitot-Static Readings." J. Dalmon, Grad. I.E.E., and H. J. Lowem, B.Sc., A.M.I.E.E., (C.E.A. Research Laboratories).
7. "Probe Equipment for Furnace Investigations in Power Station Boilers." M. E. Peplow, B.Sc., A.Inst.P., A.M.I.E.E., (C.E.A. Research Laboratories).
8. "Pulverised-Fuel and Boiler Availability Since 1947." H. E. Crossley, B.Sc. Tech., M.Sc., Ph.D., F.Inst.F., (Scientific Advisor) and E. M. Hamilton, B.Sc., A.R.I.C. (Assistant to Scientific Adviser, Chief Engineer's Department, C.E.A.).
9. "Sampling and Size Analysis of Pulverised-Fuel and Fly-ash." T. H. Hughes, A.M.Inst.F. (Fuel Research Station, D.S.I.R.).
10. "Developments in Cyclone Firing and Pulverised-Fuel Firing of Low Volatile Coals." W. G. Marskell, B.Sc., F.Inst.F. (Superintendent, Research Department, Babcock & Wilcox Limited).
11. "Ten Years' Development in Large Pulverised-Fuel Fired Boilers." R. F. Davis, M.Sc. (Eng.), M.I.Mech.E., A.C.G.I., D.I.C. (International Combustion Ltd.).
12. "Developments in the Use of Low Volatile Coals in South Wales for Steam-raising Purposes." B. S. Gylee, B.Sc.(Eng.), A.M.I.E.E., M.Inst.F., and W. Lloyd Williams, A.M.I.E.E., A.M.Inst.F. (C.E.A., South Wales Division).
13. "Some Design Requirements and Operating Experiences with Pulverised-Fuel Milling Plant." K. E. Dadswell, B.Sc. (Eng.), M.Inst.F., and F. Dransfield, B.Sc. (Eng.), M.I.Mech.E., A.M.I.E.E., M.Inst.F. (C.E.A.).
14. "Utilisation of Pulverised-Fuel Ash (Fly-ash)—P.F.A." H. W. G. Dedman, B.Com. (Lond.), M.Inst.T., A.M.I.I.A., and A. E. Hawkins, B.Sc. (Eng.), A.M.I.E.E. (C.E.A.).
15. "Pulverised Brown Coal for Power Generation in Victoria." F. H. Roberts, A.M.T.C., M.I.E.Aus., F.Inst.F. (Chief Engineer, Director, John Thomoson (Aus.) Pty., Ltd., formerly Mechanical Engineer, State Electricity Commission of Victoria).
16. "Pulverised Coal Firing in Germany: Development and Trends." W. Gumz, Dr.-Ing., F.Inst.F. (Coal Utilisation Department, Steinkohlenbergbauverein, Essen, Germany).
17. "Problems Arising from the Use of High-Ash Coals in Thermal Power Stations." G. Bouttes, E.S.E., (Director, Service des Centrales Electriques des Houilleres du Bassin du Nord et Pas de Calais) and A. Vellard, E.N.S.M.P., et E.S.E., (Engineer, Service des Centrales Electriques des H.B.N.P.C.).

Development of Large Turbo-Alternators

THE trend towards the installation of larger turbo-alternators, as the most economic means of generating electricity in thermal power stations, has presented to the designers and builders of alternators a number of problems. The primary limitations on increasing unit outputs are, of course, those of size and weight, and while to a large extent these are interdependent, each has a separate influence on the changes in design that are required. For example, when considering an increased size, the differential thermal expansion effects, particularly between copper and steel, are found to be more serious, and the production of sound forgings having the necessary higher physical properties becomes increasingly difficult. Apart from this, the mere physical dimensions of the stator frame preclude transport by rail in this country, in view of the Ministry of Transport weight limit of 150 to 160 tons net for movement by road. In this connection it should be remembered that the stator weight of the 100-MW machines of immediate post-war designs are close to this figure, and, while some increase in output could be obtained by raising the hydrogen pressure and by adopting a " two-piece " type of construction in which the core and windings are built and transported separately for assembly in the main frame at site, it became clear some years ago that a much more fundamental change was necessary if the use of units with outputs above 200-MW was to become established practice.

As a result of research and experimental work in this field The English Electric Co. Ltd. have designed an alternator in which the rotor and stator are directly cooled by the circulation of hydrogen, and which they anticipate will be suitable for outputs of at least 300-MW. At the present time a machine rated at 120-MW is undergoing works tests, prior to installation at the Willington " A " power station of the C.E.A. There it is to be rated at 110-MVA and a p.f. of 0.9 as opposed to a normal rating of 150-MVA at 0.8 p.f. The design problems involved in this development were outlined by Mr. V. J. Vickers, chief designer, turbo-alternator section, machine design department, at a symposium held recently at the company's Siemens Works at Stafford.

The available magnetic materials have for some time now been worked to their limit, and, apart from the small advantage that can be gained from the use of oriented grain steel for the manufacture of stator cores, no substantial increase in output can be expected in this direction. Any uprating must, therefore, be obtained by raising the loss intensity in the stator and rotor windings. This in turn necessitates the use of a much more effective method of heat removal by direct, or conductor, cooling ; the coolant being circulated in actual contact with the copper, thus eliminating the thermal barrier of the insulation around the coils. The overall effect of this can be seen in the graph, Fig. 1, which shows to a base of hydrogen pressure, the current carrying capacities for a given temperature rise, of the stator and rotor windings when directly cooled as compared with those obtained for conventionally cooled units. These curves emphasise the influence of the gas pressure in machines of the new type in which the temperature rise of the gas itself now becomes the major component in the total temperature rise of the copper.

When considering the coolant to be used, at first sight a liquid is the obvious choice. The application of water or oil to the cooling of the stator coils, while introducing considerable complications is, in fact, quite practicable ; but in the cases of the stator core and of the rotor winding, which is the most highly rated part of the machine, the problems are more formidable, and for these latter components there would appear to be no alternative to the use of hydrogen. A closer examination of the problems involved in the use of a liquid coolant for the stator windings reveals that owing to the high voltage of the windings, it is impracticable to provide openings in the stator coils for the inlet and exit of the coolant other than at the ends, so that the coolant flow path must extend at least over the full length of a coil side or of a number of coil sides in series. In order to employ liquid it is essential that the ducts are sufficiently robust to ensure that leakage cannot develop ; in effect this means that some, or all, of the individual laminations employed to make up the conductors have to be tubular in form. Furthermore, since the eddy current loss in a lamination

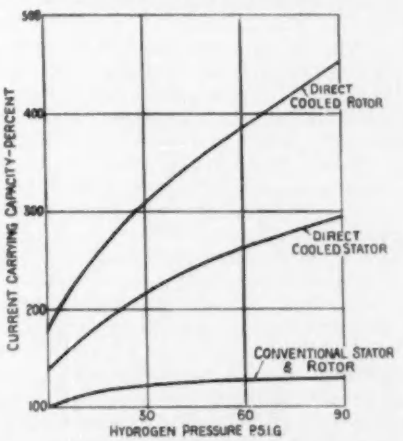
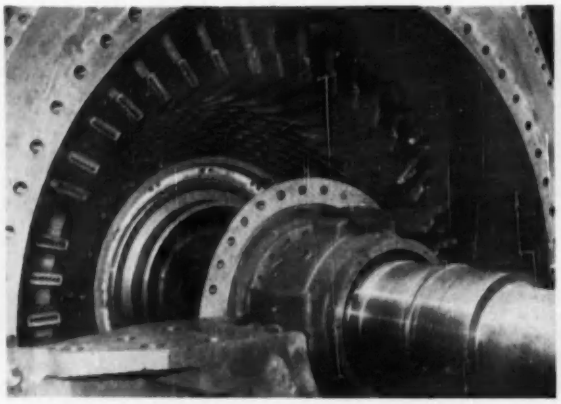


Fig. 1. Curves showing the variation of current carrying capacity with hydrogen pressure.

is proportional to the fourth power of the depth, the tubular lamination must necessarily be kept very small if the eddy current losses are to be held down to such a value that they do not result in a lowering of the machine efficiency. With very small sizes there is the risk that ducts may become blocked, and there are manufacturing problems both in the production of the tubes themselves and in their brazing to form the connections from coil to coil. On the other hand if gas is used, there is no problem of leakage and the ducts can be formed from thin-walled material of relatively large section and independent of the current carrying strands. The pressure drop along such a coil side can be readily made equal to that required by the rotor, and by the stator core if it is also cooled by axial rather than by the more usual radial ducts. Thus, an overall ventilation system



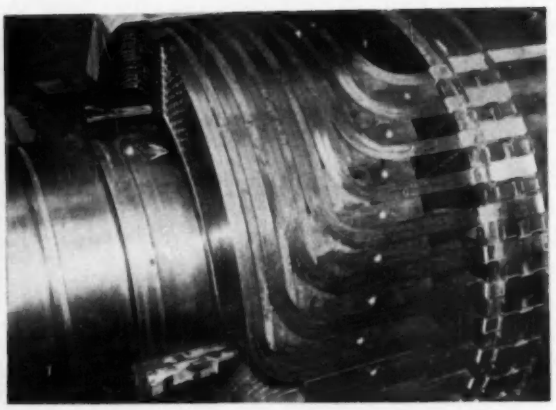


Fig. 2 (left). A view of the new design English Electric direct-cooled alternator, showing the stator windings. Fig. 3 (right). This view of the direct-cooled alternator shows the hollow rotor conductors.

can be achieved which is claimed to be very efficient in terms of both cooling and pumping power loss, particularly as only about a quarter of the rate of gas circulation around the machine as a whole is required compared with a conventional alternator of the same rating.

As a result of the lower heat capacity of hydrogen compared with water or oil, the space factor of the gas-cooled coil is lower than of the liquid-cooled coil and, therefore, some small reduction in overall core diameter and weight can be achieved by the use of a liquid. This possible gain is, however, relatively small unless the current density is increased to such an extent as to result in a significant reduction in the efficiency of the machine as a whole. It has been found possible to design for anticipated outputs up to at least 300-MW, without taking advantage of this, and the company has developed a completely gas cooled design in order to keep the machine as simple as is practicable. While the self-fanning action of the rotor produces a certain circulation of gas, the differential pressure available from this source is small, and to obtain the benefit of the full potentiality of this system of cooling a very substantial pressure boost is essential. As mentioned previously, the pressure requirements of the three main circuits of rotor and stator coils, and of the stator core, can readily be made the same, resulting in the maximum overall efficiency. The pressure required is, however, much higher than can be obtained from the hitherto normal axial-flow fans on the rotor shaft and consideration therefore has been given to the means of obtaining this additional pressure. Although the rate of gas circulation is low, the basic pressure of 30 lb./sq. in. and upwards, together with the high differential required results in a pumping power which is significant in the total machine losses and it is, therefore, important that the maximum efficiency should be obtained on the blower. If the blower were mounted on the main shaft the number of stages necessary would be large and the entry and exit conditions restricted and aerodynamically very inefficient. Further, the assembly of such a blower and the provision for sufficient axial movement of the rotating blades to allow for thermal expansion effects in the main machine would be difficult, apart from causing a large reduction in the first and second critical speeds of the alternator shaft due to the substantial extra length required between bearings.

For their direct-cooled alternator, therefore, the company has adopted an entirely separate blower unit which is mounted in the upper part of the stator frame in the existing space between the two axially arranged coolers. In this position no increase in frame dimensions is necessary and a full diffuser can be incorporated on the blower outlet. The blower designer has freedom of choice as regards speed and number of stages. The drive is taken from an extra pinion on the exciter gear box via a cardan shaft arrangement. A view of the end of the stator coils showing the gas ports is shown in Fig. 2. In the new design, the gas enters each half coil at one end of the machine and leaves at the other. This arrangement allows a reasonable pressure drop and reduces to a minimum the differential thermal expansion between the two coil sides in a slot, and between the coils and the core. Fig. 3 is a close-up of the rotor end windings, from which it can be seen that the ports for the gas to enter and leave the tubular conductors in the end turns are in the side walls. This arrangement eliminates the risk of any slight relative movement of the turns, which can occur in the end region, causing partial restrictions to flow if the ducts are formed in a radial direction through the conductor stack.

The gain in current carrying capacity from raising the hydrogen pressure is very considerable in the case of conductors which are direct cooled, as can be seen from Fig. 1, and the trend is towards the use of pressures in excess of 30 lb./sq. in. In order to cater for these higher pressures it has been necessary to carry out development in connection with hydrogen shaft seals. A very extensive programme of work on these was carried out by The English Electric Co. Ltd., using a test rig, on which full size seals up to the largest diameter visualised for future use were tested, working with hydrogen up to pressures several times greater than the maximum so far employed. The rig shaft was run with vibration amplitudes well in excess of those likely to be met with in service.

Central Electricity Generating Board Appointment

It is announced that Lord Mills, Minister of Power, has appointed **Mr. Leonard Rotherham,** a director of research and development at the Industrial Group Headquarters of the United Kingdom Atomic Energy Authority, to be a full-time member of the Central Electricity Generating Board. We understand the appointment will take effect from April, 1958.

Conference on N.I.F.E.S. Annual Report

THE importance of using our coal supplies as efficiently as possible has been increasingly realised since the Suez crisis, when the extent of our dependence upon imported oil to make up the deficiency of our indigenous fuel supplies, of which coal is the most important, was realised. Unless there is a major recession in our industrial development, coal production in this country will fail to meet industrial demands for heat and power, and until nuclear energy can fill the gap, which is unlikely for at least a decade, we must either import large quantities of fuel, or make our available supplies go much further by using them more efficiently.

Ever since the initial campaign of the Fuel Efficiency Committee set up by the then Minister of Fuel and Power, the possibilities of saving fuel by more efficient methods of utilisation have been pointed out. Perhaps the most emphatic statements in this connection were made by Sir Oliver Lyle in a paper presented to the Institute of Fuel, entitled "Inefficiency," in which he demonstrated that the average overall efficiency with which fuel was used in this country was probably of the order of 20 per cent. and that savings amounting to as much as 80 million tons per annum could be made if the urge to economise were sufficiently great. It is true that much has been done by individual firms, but the fact that, in general, there has been little improvement has been shown conclusively by the Third Annual Report of N.I.F.E.S. Fortunately, the report does not stop there, but goes on to show very definitely that great savings can be made simply by improved plant operation, and still greater savings by a relatively small capital outlay. For example, on the basis of surveys already carried out, it is estimated that, on Lancashire boilers alone, at least 3 million tons of coal per annum could be saved for a total capital outlay of approximately £14 million.

The facts contained in this report and their implications were thought by the Combustion Engineering Association to be of such importance that it was decided to hold a conference devoted entirely to their consideration, with the objective of stimulating action on the part not only of members of the Association, but of industry in general. The conference was held at Harrogate on November 5th-6th, under the chairmanship of Mr. S. P. Chambers, C.B., C.I.E., deputy chairman, Imperial Chemical Industries Ltd. and part-time director of the National Coal Board. Sir Leslie Hollingshurst, G.B.E., K.C.B., chairman, N.I.F.E.S., opened the proceedings, and both Dr. Macfarlane, chief executive, and Mr. Clegg, chief engineer, N.I.F.E.S., addressed the gathering. They covered in broad outline the report itself and dealt in more detail with the results of tests on Lancashire boilers, the factors leading to low efficiency, and the means of remedying them. Following these addresses, which made the scope and conclusions of the report quite clear, the conference divided into a number of "syndicates" for a more detailed discussion of the points and queries raised in the report, and in Mr. Clegg's address. Finally, the conference as a whole considered the reports of the individual syndicate leaders, their general conclusions being summed up by the chairman.

Adequate reference has been made to the report in this* and other journals, and the main contents should by this time be widely known. They may perhaps be briefly summarised as follows :— N.I.F.E.S. offer a service to industry in the form of heat and power surveys by means of which part or all of a works or process is examined quantitatively as regards efficiency in generating and utilisating heat and power, and advice and help is given in rectifying any deficiencies found. If the plant is put in order a regular service agreement is available by which visits are made to assist in maintaining the higher standard achieved. Special problems presented to N.I.F.E.S. are dealt with by a specific advisory service.

The report sets out figures showing the increased use of these services now being made by industry, and outlines the results obtained to date. During the year ended March 31st last, 434 general purpose heat and power surveys were carried out and these showed that on an average, it should be possible to save 18.4 per cent. of the fuel being used by these installations at the time of the survey.

Particular attention is paid in the report to tests made on Lancashire boilers, as they are more commonly used in industry, and are perhaps more prone to inefficient operation. This latter fact is due partly to features of design which include brickwork settings which are liable to air leakage if not well maintained, and partly to the age of many boilers of this particular type still in use. A large number are, in fact, still hand-fired. The average efficiencies obtained for solid-fuel-fired Lancashire boilers are summarised below :

	(efficiency per cent.)
402 boilers—with economisers ..	65.1
153 boilers—without economisers ..	55.8
555 boilers (weight average of above)	62.5
Target efficiency with economiser ..	75.0

For individual efficiencies and other data the reader must be referred to the report itself. The general conclusions as given by Mr. Clegg were that there had been little improvement in boiler efficiency during the past 35 years, in spite of the efforts that had been made through the mediums of publicity, education and training, to ensure that owners and operators became fuel efficiency-minded, and the efforts of research organisations to improve the design of combustion appliances.

The discussions resulting from the reports of the various syndicates are summarised below :—

1. Instrumentation of boiler plant

Discussion first took place on the servicing arrangements and resources of instrument manufacturers. Should these be pooled in order to avoid delay in placing defective instruments back into service, and to eliminate

*ENGINEERING AND BOILER HOUSE REVIEW, October, 1957, pp. 347/348.

unnecessary duplication of effort? A central pool of spares could be used to replace instruments under repair and so maintain continuous control of plant operation. On the other hand, the manufacturer's reputation depended on satisfactory maintenance and servicing, and this was not always given by the "general practitioner." The leading instrument manufacturers had their own schools in which to train repair and maintenance men. It was suggested that many instruments were not continually in operation due to apathy on the part of the users, and that instruments out of action sometimes served to mask faulty plant performance. It was also pointed out that many instruments were not "telling the truth," and that when repairs were necessary they should be regarded as urgent. The need for instruments of more rugged construction was stressed, and it was also felt that some minimum standard of instrumentation should be laid down, possibly by N.I.F.E.S., and that on smaller installations indicators rather than recording instruments should be installed.

The chairman in summing up said it would appear that the present arrangements could be improved, but this was a matter for the instrument manufacturers. A central servicing arrangement might have its difficulties for them as their reputations depended upon satisfactory maintenance. He suggested that a study group, set up possibly by the Combustion Engineering Association, might be useful in formulating recommendations.

2. Simplified boiler control

Good and efficient boiler control requires the continuous attention of trained operators, and these are increasingly difficult to obtain. The development and application of simple methods and systems of automatic control were therefore desirable. A minimum standard of control might possibly be set up by N.I.F.E.S. It was suggested that "boiler loss" meters, i.e. meters indicating total losses, which would be a measure of flue gas losses plus other losses assumed to be constant, would be useful. These "other losses" were not necessarily constant for different plants, but an adjustable setting might possibly make allowance for this. The need for a simple air/fuel controller was stressed by a number of speakers and it was pointed out that whilst this was relatively easy in connection with oil-fired boilers it was likely to be costly on shell-type boilers fired with solid fuel, although such a controller was often used on water-tube boilers. Steps were being taken by a large research organisation to develop an inexpensive but effective air/fuel controller. Under the Clean Air Act a simple form of smoke indicator would also be required. Dr. Macfarlane said that N.I.F.E.S. would consider the question of a specification for minimum control apparatus and that a discussion with the manufacturers might be desirable. He pointed out that a coal-fired "packaged" boiler was available in the U.S.A., and that the cost of air/fuel control apparatus for such a unit is of the order of £200 to £300.

3. Training of operatives

The N.I.F.E.S. report, it was suggested, showed that progress in this matter was far too slow, and a discussion took place as to whether the remedy lay in compulsion, or increased incentives. The trade unions sometimes stood in the way, but they were not likely to object to higher pay for trained men. It was considered that at least one man on every shift should be trained. On the other hand, automatic control would reduce the number of trained men required. Training could be encouraged by employers, by N.I.F.E.S. and by senior plant engineers. There was a divergence of opinion as to compulsory training, and on the subject of incentives, it was pointed out that these usually depended on accurate instruments. Incentives in principle were approved, and it was stated by one speaker that the services of a skilled operator lie at the root of all efficiency, and certification of operators would go a long way towards solving the problem. There was a need for skilled demonstrators. Dr. Macfarlane remarked that in the U.S.A. there were local systems of certification, designed to promote safety rather than efficiency. It is well known that N.I.F.E.S. offers a training course for boiler operators, and some 2,000 trainees had attained the City and Guilds requisite standard during the last two years.

The chairman said that the discussion as to the desirability of certification was not conclusive. Some form of training was clearly necessary. As regards incentives, the increased profits resulting from higher efficiency should provide funds for higher pay.

4. Manufacturers and operating efficiency

One participant in this discussion group asked if plant manufacturers had sufficient incentive to improve plant design, and whether they provided operators with adequate operating instructions, and make available sufficient servicing facilities. Also, whether they had the resources and material supplies to meet the demands of industry for new and efficient plant. The manufacturers seemed confident that they could supply all the plant required, and could obtain the necessary material supplies. It was suggested that often the plant manufacturer had insufficient information as to the coals available. This, it was pointed out, could be obtained from the N.C.B., but no one could give a guarantee that supplies would remain the same over a long period. The solution was to design plant to burn a reasonably wide range of coals. Reference was made to the increasing fines content of industrial coals, and to the fact that the cost of removing them was prohibitive. The operators of small plants could not always obtain sufficient guidance on the methods of burning difficult coals, and it was suggested that N.C.B. should set up a demonstration plant as part of its service. A further complaint was that in many cases the plant manufacturers' instructions did not reach the men really concerned.

In summing up, the chairman referred to the cost of coal preparation and the need for users to install equipment to burn the lower grades which would often prove to be cheaper in the end.

5. Co-operation between N.I.F.E.S. and plant manufacturers

It was suggested that plant manufacturers were not always informed when tests carried out by N.I.F.E.S. showed poor efficiency, and that in such cases the manufacturer had no opportunity to investigate the causes of the trouble. They would like to know when the actual tests were being made. There were also occasions when the manufacturers did not inform N.I.F.E.S. of new developments in plant. Results of

tests might sometimes be interpreted differently by N.I.F.E.S. and the makers of the plant. It was stated by a representative of N.I.F.E.S. that there was frequent and fruitful contact with the manufacturers. It was also urged that this co-operation should be extended to the fuel distributing concerns.

The chairman summed up by saying that there seemed to be no differences in principle between N.I.F.E.S. and the makers of plant but that in certain cases there was a need for closer and more enthusiastic collaboration.

6. N.I.F.E.S. and the fuel distributors

It was suggested that co-operation in this field varied with the district and the local N.I.F.E.S'. personnel. One speaker thought that N.I.F.E.S'. directorate should include a representative of the fuel distributors, and that the distributors should be informed when N.I.F.E.S. made tests at installations to which they were supplying fuel. In general, however, it was felt that there was good co-operation between the two parties, but Dr. Macfarlane agreed that closer and more fruitful contacts might be possible in the future, and this would be considered. He did not think that fuel distributors as such should be represented on the directorate, because a director should consider himself as part of N.I.F.E.S. and not as representing some other interest.

The chairman commented that fuel distribution was part of industry, and that these points needed further consideration.

7. Apathy in industry

Although management was at last becoming more interested in fuel efficiency, there was still a considerable amount of indifference shown in certain quarters. This could be partly caused by engineers themselves through a fear that N.I.F.E.S'. surveys might show up their plant deficiencies. On the question of pricing it was suggested that the N.C.B. policy was not always understood, and sometimes the wrong type of plant was recommended for the coals available. A speaker suggested compulsory registration with N.I.F.E.S. of all plants above a certain size. The Government loan scheme, it was suggested, required too many details in applications for help, and also on this subject it was asked if the aim of the scheme was to save coal or to finance industry. Many approved schemes were turned down on financial grounds. One of the most important points made during this discussion was that N.I.F.E.S'. services must be put across to industry as a financial proposition ; namely that they would save money, either in the form of a reduced coal bill or by increased output of a higher quality. Coal could under certain circumstances be replaced advantageously by a higher grade fuel such as gas. Many users were not aware of their plant deficiencies, and it was even suggested that some form of incentive for management was required. Sir Sydney Frew (Ministry of Power) was of the opinion that the Government Loan Scheme was working satisfactorily.

The chairman pointed out that apathy existed with regard to many things besides fuel efficiency. We could never hope to make every one efficient, and it was useless to set up impossible targets. One of the engineer's weaknesses was that he is often inarticulate to non-engineers. He tended to concentrate on certain technical efficiencies and neglect such aspects as output and cost. It was difficult to sell fuel efficiency *per se*.

8. Works managers and plant efficiency

The view was expressed that expert salesmanship was needed on the part of N.I.F.E.S. to ensure that works managers were made aware of their plant deficiencies. This was especially so as regards higher management. Those who supervised plant should themselves undertake some form of training. Dr. Macfarlane was confident that N.I.F.E.S. had the necessary resources to cope with increasing demands from industry, without undue delay.

9. What should be the aim of N.I.F.E.S.?

Delegates attending this discussion group raised a number of questions. Were the basic aims of N.I.F.E.S. correct ? Did they aim at saving coal or reducing imports ? What was their policy regarding small coal ? Should their recommendations be directed to replacing high quality coal by smalls ? As regards the use of lower grade smalls, this was considered desirable, but some doubt was expressed as to the adequacy of the incentive provided by the present price structure. If a user equipped his plant to use these low-grade coals he would require some guarantee that the supply would be maintained for at least a minimum period. If imports were to be reduced this would necessitate the replacement of higher grades in this country by smalls. Was this not the function of the distributor ? Dr. Macfarlane said that N.I.F.E.S. must assist the user to try and save money. The position was constantly changing, and greater all-round efficiency was required to allow all demands to be met. Large coal was still used in older plants at low efficiency, and there was an enormous consumer resistance to a change of policy in this connection.

The chairman said that there might be an overall coal shortage or merely a lack of balance between the different grades. It was difficult for the N.C.B. always to estimate correctly the relative influence of these two factors. The balancing of demand for various grades would be a slow process.

Comment

It would appear that the conference has served a very useful purpose in bringing together the various sections of industry concerned with fuel utilisation, and should do much to make the user, including management, fuel-conscious. It will probably take time for N.I.F.E.S. and the various other organisations concerned to digest all the information and points of view placed before them, but it may not be too optimistic to hope that, at last, industry may begin to realise the immense savings inherent in fuel efficiency. The conveners of the conference, the Combustion Engineering Association, are to be congratulated on their initiative and upon the response which it has received.

Members of the Canadian Trade Mission which recently made a four-week tour of Britain, visited the Renfrew works of Babcock & Wilcox Limited, on December 3rd. These works, which are the largest in the world devoted to the manufacture of conventional and atomic steam-raising plant, have manufactured all the heat-exchangers for both the Calder Hall and Chapelcross nuclear power stations, and they are making a major contribution to the design and construction of plant for the atomic power station to be built for the C.E.A. at Hinkley Point in Somerset. The members were received by Sir Kenneth Hague, deputy chairman and managing director of the company.

Central Electricity Generating Board

IN a recent issue of this journal we reported the appointment of the chairman, deputy-chairman, and other full-time members of the Central Electricity Generating Board—which, with the Electricity Council, has been established in consequence of the Electricity Act, 1957.

The new Central Electricity Board has now published details of the organisation which it has set up, and which operates from January 1st, 1958. They propose to devolve more responsibility, autonomy and power to their provincial establishments. Briefly, the existing generating divisions are retained as operational management units, but they are to form five groups under "regional directors." It is intended that regional executive committees shall take over accountancy and some administrative functions within the broad policy rulings laid down in the Central Board. The existing technical organisations will remain under the divisional controllers.

The development of the industry is such as to make it impossible to secure a uniform load on the construction staffs of the eleven divisions of the C.E.A., or even the five newly-established regions; the Board has, therefore, established three separate "engineering project offices" as follows:—(1) North (possibly at Leeds or Manchester) working for the North West, Merseyside and North Wales, North Eastern and Yorkshire areas; (2) Midlands (possibly at Birmingham or Nottingham) working for the Midlands, East Midlands and South Wales areas; (3) London, working for the London, Eastern, South Eastern, Southern and South Western areas.

The project offices will undertake construction of new stations or major extensions to existing stations and will deal with nuclear as well as conventional power stations.

The five regional directors are:—*North Eastern and Yorkshire*:—Mr. P. Briggs, A.M.I.Mech.E., M.Inst.F.; *Midlands and East Midlands*:—Mr. R. L. Batley O.B.E., A.M.I.Mech.E.; *Eastern, London, and South Eastern*:—Mr. A. R. Cooper, M.Eng., M.I.E.E., M.Inst.F.; *Southern, South Western and South Wales*:—Mr. A. C. Thirtle, A.M.Inst.C.E., A.M.I.E.E., M.Inst.F.; *North West, Merseyside and North Wales*:—Mr. W. C. Parker, M.I.E.E., M.Inst.F.

Mr. Briggs was, until December 31st, 1957, controller of the Yorkshire Division of the Central Electricity Authority. Before his appointment in March of last year, he was deputy controller of the North West, Merseyside and North Wales Division. When the electricity supply industry was re-organised in 1948, he was made responsible for the control and operation of all the power stations in the South Eastern Division, and later became controller of the Merseyside and North Wales Division before it was merged with the North Western Division in 1954.

Mr. Batley had been controller of the Midlands Division for the past five years, and was previously chief generation engineer (operation) of the Merseyside and North Wales Division. Prior to nationalisation he held power station appointments at Bradford, Hackney, Neasden and Swansea, and at Vesting Date he was superintendent engineer of generation of the Liverpool Corporation Electricity Supply Department.

Mr. Cooper, who is a full-time member of the Central Electricity Generating Board, was formerly controller of the North-West, Merseyside and North Wales Division, C.E.A. He joined the Central Electricity Board, Operations Department, North-West England and North Wales, in 1935, and became chief operations engineer of the Board in 1944. He was appointed controller of the Merseyside and North Wales Division in 1948, and of the North Western Division in 1951.

Mr. Thirtle had been controller of the South-Western Division for the past seven years and was previously chief generation engineer (operation) of the Eastern Division. After holding various posts with the Norwich Corporation Electricity Department, Mr. Thirtle, who went to Swansea in 1939 as deputy chief engineer and manager, was appointed City electrical engineer and manager at Carlisle in 1944. He took up his appointment with the Eastern Division on Vesting Day.

Mr. Parker had been controller of the South Eastern Division since 1948. Prior to nationalisation he was for fifteen years with Fulham Borough Council Electricity Department, and for the last thirteen years was borough electrical engineer. During the latter part of this period, he acted as electrical and mechanical engineering consultant to the council for the extension and construction of the Fulham power station. He was awarded the Telford Premium of the Institution of Civil Engineers, 1937-38. Earlier in his career, Mr. Parker had wide experience both at home and abroad on the engineering and commercial side of electrical plant and equipment manufacture, including service with the English Electric Co. Ltd. and Crompton Parkinson Ltd.

In addition to the above appointments, Mr. H. J. Bennett, A.M.I.E.E., has been appointed controller of the London Division and deputy director of the Eastern, London, and South Eastern Region.

Mr. Bennett had been controller of the South Wales Division since 1951, and was previously chief generation engineer (operation) of the London Division. He held appointments successively with the Portsmouth Corporation, the Powell-Duffryn Company and, as charge engineer at the Padiham power station of the Lancashire Electric Power Co. In 1929 he joined the London Power Co., holding appointments first at Deptford and later at Battersea power station, where, in 1944, he became chief assistant engineer. Later he moved to headquarters of the company as chief assistant engineer (generation).

The three chief project engineers who take charge of the three engineering project offices are:—*North* (North West, Merseyside and North Wales, North Eastern and Yorkshire areas)—Mr. C. W. A. Priest, B.Sc. (Eng.), A.M.I.Mech.E., M.I.E.E.; *Midlands* (Midlands, East Midlands and South Wales areas)—Mr. R. R. Maddock,

B.Eng., A.M.I.Mech.E., A.M.I.E.E. ; *London* (London, Eastern, South Eastern, Southern and South Western areas)—Mr. T. Yule, M.Eng., M.Inst.C.E., M.I.Mech.E., A.M.I.E.E., M.Inst.F.

Mr. Priest had been chief generation engineer (construction), South Wales Division of the Central Electricity Authority, since August, 1953, and was previously generation engineer (construction) of the Southern Division. After service in the 1914-18 war, he took a three-year full-time course in electrical engineering at Portsmouth College and received his training at the Dick Kerr Works of the English Electric Co. Ltd. In 1923, he joined the London Electric Supply Corporation as an assistant engineer at the Deptford power station, where, subsequently, after the station was taken over by the London Power Company, he became turbine-house engineer. He was turbine and electrical operating superintendent at Fulham power station for three years, when, in 1939, he joined the Battersea Borough Council Electricity Department as chief assistant engineer, later becoming deputy general manager and engineer.

Mr. Maddock had held the position of chief generation engineer (construction), Midlands Division, since December, 1951, and for four years previously was generation engineer (construction), Eastern Division. He served his apprenticeship with Metropolitan-Vickers Electrical Co. Ltd., and was later engaged with the company on projects and contracts for complete power station layouts, and workshops for large electrified railway schemes. In 1938, he became assistant power station engineer of the Northmet Power Company, and was appointed power station engineer (construction) in 1946. Major works for which Mr. Maddock was responsible included extensions to the Brimsdown "B" power station, reconstruction of the Willesden power station, and design and layout of the power station at Rye House.

Mr. Yule had been chief generation engineer (construction) of the Eastern Division since March, 1948. He took a degree in engineering at Liverpool University and served a college apprenticeship with Metropolitan-Vickers Electrical Co. Ltd., with whom he was subsequently employed on erection contracts at home and abroad. From 1933 to 1938 he was employed in the power department of Imperial Chemical Industries Ltd., and later held various appointments with the Sheffield Corporation Electricity Department. After a short period in 1943 with the West Midlands Joint Electricity Authority as assistant resident engineer, at Ironbridge power station, he joined the Brighton Corporation Electricity Department in January, 1944, as power station superintendent and became deputy engineer and manager in the following year.

NEW COOLING SYSTEMS FOR POWER STATIONS

The use of cooling towers that are not dependent on large volumes of make-up water is being investigated by the Central Electricity Authority. Announcing this, the Authority say they consider the potentialities of the new system should be thoroughly explored as part of the continuing search for new and improved techniques of power generation, and that to this end negotiations are in hand for the design and construction of a commercial scale installation. We understand that the new system employs jet condensers within the power station, and that the water to be cooled is pumped in a closed circuit through large heat-exchangers arranged around the base of the dry cooling tower. The heat-exchangers must be designed to transfer the whole of the waste heat direct to the air passing upwards through the towers, whereas in conventional water-cooled towers most of the heat is lost by evaporation of water. For this reason it will be necessary to circulate more than three times the amount of air through the dry towers as is necessary in water-cooled towers of equal capacity. The dry cooling system will require a larger structure, occupying additional ground space, and it would seem likely that it will prove more costly than existing water-cooled installations. On the other hand, should it prove successful in operation, the extra cost might, under certain circumstances, be partly off-set by economies in other directions. For example, there would be a saving in fuel transport costs if coal-fired stations would be sited closer to collieries in water-scarce areas.

NEW BOOKS

"Analar Standards for Laboratory Chemicals." *Fifth edition. Type area 4½ in. × 7⅛ in. 397 pages. Published by The British Drug Houses Ltd., B.D.H. Laboratory Chemicals Group, Poole, Dorset, and Hopkin & Williams Ltd., Chadwell Heath, Essex. Price 21s.*

This book provides chemists with a series of specifications for laboratory chemicals which are sold by and carry the guarantee of The British Drug Houses Ltd., and Hopkin & Williams Ltd., under the trademark "Analar." A number of reagents appear for the first time in this edition, while on the other hand, certain items included in previous editions have now, for various reasons, been discontinued. Some rearrangement has resulted from the adoption, in the main, of the "Recommended Names for Chemicals used in Industry," of B.S. 2474 : 1954, and several new practices have been adopted for certain tests that occur repeatedly in the text.

"Design of Steel Structures," *by Edwin H. Gaylord, Jr., and Charles N. Gaylord. Type area 4½ in. × 7 in., 540 pages, 248 line and half-tone illustrations. Published by the McGraw-Hill Publishing Co. Ltd., 95, Farringdon Street, London, E.C.4. Price 60s.*

The loads for which bridges must be designed are discussed in an introductory chapter, and this is followed by dissertations on the design of structural members in steel and aluminium ; welded, riveted and bolted connections ; plate-girder bridges ; and industrial and multi-storey application of theories of ultimate strength-plastic design, or, as it is referred to in this country, the "collapse" method of design. Each topic is introduced by a discussion of the relevant theory, and with references to experimental evidence, wherever feasible. Illustrative examples and problems follow this introduction ; every effort being made to relate both examples and problems to practical situations. Adequate references to the literature of this subject are included.

KELVIN HUGHES EXHIBITION IN GLASGOW

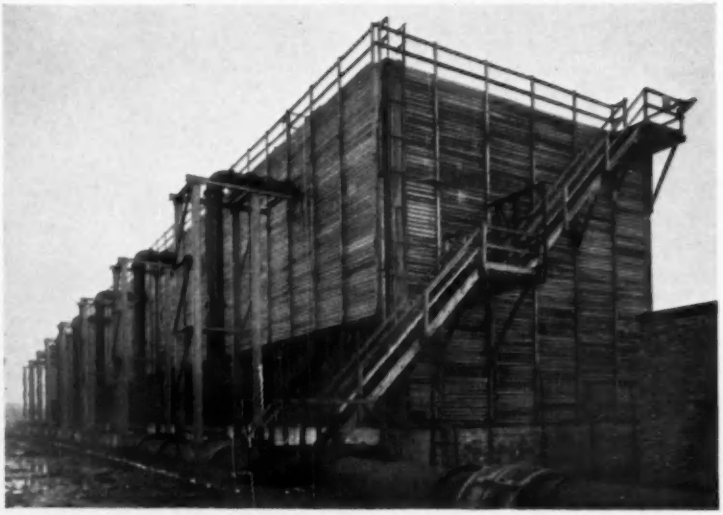
Although the social implications of smoky cities and towns are well appreciated, too few industrialists and directors of enterprises that could do much to assist smoke abatement are aware of the modern equipment which is now available to help them to increase boilerhouse efficiency and reduce smoke pollution. Clean air, a standard in this country far too long overlooked, has become one of the goals of better living. In Glasgow a few weeks ago a private two-day exhibition was staged by Kelvin & Hughes (Industrial) Ltd. The exhibition was designed to show equipment that will increase boiler efficiency, and keep the nuisance of smoke emission to a minimum. Newly-developed instruments to check smoke density, to analyse the gases passing up a chimney, and to control temperatures, etc., were displayed to visitors from all over Scotland and Northern England. Actual instruments on show display included—smoke density equipment : a range of low cost instruments designed to meet requirements of the Clean Air Act. Flue-gas analysers : instruments for the continuous analysis, indication and recording of flue gas contents, and boiler-plant instruments : such as draught gauges, flowmeters, indicator recorders, etc. Also shown were instruments for temperature control, these including examples of a range of new transistor-type indicating controllers with two positions, proportional or three position action. There was also portable, single and multi-point instruments, pyrometer and resistance bulbs for temperature indication.

Induced-Draught Cooling Towers

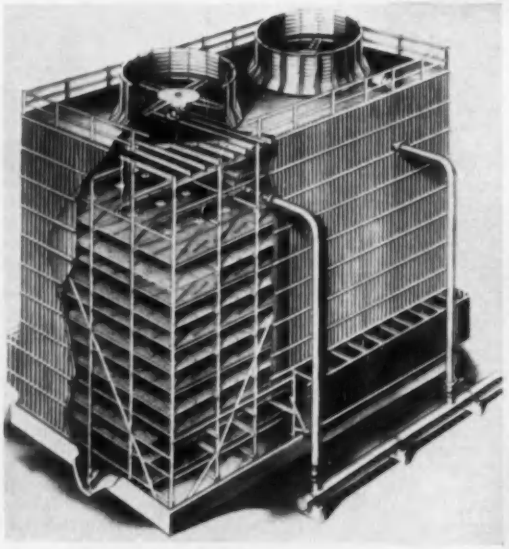
HEAD WRIGHTSON PROCESSES LTD. are responsible for the design, supply and erection of Fluor " Counterflo " induced-draught cooling towers, in this country and the British Commonwealth, under licence from the Fluor Products Co., of Los Angeles. An installation of this type was constructed for the Central Electricity Authority at Hackney " B " power station, and similar towers deal with cooling water for the " Pluto " materials-testing reactor at Dounreay, and for the " Dido " and " Pluto " reactors at the Harwell establishment of the United Kingdom Atomic Energy Authority.

The installation at Hackney is a wooden structure divided into eight separate compartments or cells. Hot water passes from the water inlet to the risers, and thence to a water distribution system. The water spray from the nozzles falls down the tower, and maximum distribution is ensured by the sloping-bar grid decking which is fitted at 2-ft. intervals. The water is cooled by air induced through the tower by fans placed above the drift eliminators. The cooled water is collected in a concrete basin below the tower from where it is pumped to the point required. The drift eliminators placed between the fans and the water distribution system eliminate the spray loss of water to a guaranteed maximum of 0.2 per cent. of the water circulated.

The main features of the " Counterflo " cooling tower, apart from the fact that it is only some 36-ft. in height, are that the system offers true counterflow cooling, with a " splash " type packing, in which the cooling is effected by disintegration of the water stream into droplets. The water distribution system is totally-enclosed, and comprises a timber header pipe and laterals, and porcelain nozzles, the use of these materials being responsible for the unit's non-corrosive and anti-clogging characteristics. Structural framework, and internal packing are of European Redwood, treated with an approved and tested timber preservative, while the tower sheathing and fan

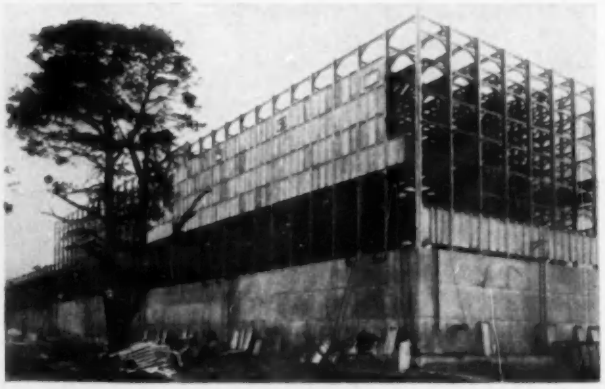


(Right). The Fluor " Counterflo " cooling tower supplied by Head Wrightson Processes Ltd. for the Hackney " B " power station of the C.E.A. This installation is of double-wall wooden construction, and is divided into eight compartments or cells.



(Left). An artist's impression, showing the general method of construction used for the Fluor " Counterflo " induced-draught cooling tower.

(Below). Partly-completed Fluor " Counterflo " induced-draught cooling tower of pre-cast, reinforced-concrete construction for a Government department. (Illustration by courtesy John Laing & Son Ltd.)



stack are of Western Red Cedar. The tower sheathing, incidentally, is a double-wall construction designed to allow the constant circulation of air between the walls. Fan equipment incorporated in the "Counterflo" towers comprises an adjustable-pitch, low-speed, propeller-type fan, mounted on a single-reduction worm gearbox, and driven by an electric motor situated outside the air-stream. A vibration cut-out switch automatically shuts off the electricity supply to the fan motors in the event of excessive vibration. Head Wrightson point out that the large degree of prefabrication possible with this type of unit makes erection a comparatively simple matter. Most of the work can, in fact, be carried out by semi-skilled labour.

The company also inform us of a further development —a concrete cooling tower using the "Counterflo" system, which has been designed and is being erected in co-operation with John Laing & Son Ltd. for a Government department.

Pilot Plant for Underground Gasification

EARLY in 1956 Humphreys & Glasgow Ltd. received a contract from the National Coal Board under which they became responsible for the construction of a pilot-scale gasification plant at Newman Spinney, and for the supply of necessary equipment up to the gas-inlet to a C.E.A. power station. Work has already started on this project, and it is expected that gas will be produced by December this year. The company will also carry out further experimental and development work that may be required, and prepare designs for a 60-MW commercial-scale gasification plant. At Newman Spinney a further 50 acres of land has been acquired to accommodate the first five arrays of the pilot plant.

The plant is being designed on the basis of the blind bore-hole technique, which method consists of drilling horizontal bore-holes in the seam of coal and inserting an air pipe along each bore-hole. The coal is ignited at the blind end of the bore-holes and air is blown into the resulting reaction zone. Hot gases pass back along the bore-hole in the annulus between the pipe and the bore and transfer much of their sensible heat to the ingoing air in the pipe. So far all experiments have been conducted with single bore-holes, the gas being piped from the exit of these bore-holes to the surface. Final preparations are now being made for the first multiple bore-hole experiment which has been prepared in one of the shafts on the experimental site. For this experiment the 315-ft. deep Sough seam is being used and four bore-holes, each 250-ft. by 12½-in. bore, have been prepared. In previous experiments the gas has been taken directly from the end of the bore-hole but in this experiment, and for the first time, the gallery and shaft will be used to conduct the gas. Water sprays, situated in the shaft and the gallery, will cool the gas to 35 deg. C. by the time it reaches the shaft top. It will thus be possible to leave the gallery end of the air pipes free to expand and so reduce the stresses which were imposed on the pipe in other single bore-hole experiments and could result in failure before a section was completely gasified. This experiment is designed to give information on the behaviour of multiple bore-holes, particularly on the problems of controlling air flow to individual bore-holes from a common manifold.

The pilot plant is being designed to produce enough gas to generate approximately 5-MW of electricity. The gas will be burned in the power station boilers, the generation of electricity being by a conventional steam turbine and alternator. A survey of the available coal measures at Newman Spinney was carried out early last year, and on the basis of this survey the positions of the first five pilot plant arrays have been fixed, preliminary surface works have been undertaken and sinking of the first shafts has commenced.

Each of the pilot plant arrays will have a concrete-lined shaft, 8-ft. in diameter, going down to the selected coal seam. From this shaft a gallery 100-yd. long will be driven into the coal seam and from either side of this gallery bore-holes 100 yd. long will be drilled in the coal seam at 10-yd. intervals. Thus there will be ten bore-holes on each side of the gallery embracing an area of approximately 20,000-sq. yd. of coal seam. Air will be conducted to the far end of each bore-hole by air tubes in the bore-hole, which are fed via blast mains running down the shafts and gallery with air from a central blowing plant adjacent to the power station. Gas returning along the bore-holes will be cooled by water spraying in the gallery and shaft, the top of the shaft being capped with a gas offtake connected by surface mains to the power station boiler-house. The sprays of cooling water will also serve to scrub the gas and the contaminated water will flow into sumps at the end of each gallery, from where it will be pumped back to a surface storage tank for recirculation.

In order to supply the gas requirements of the power station two such arrays will be gasified together, and it is estimated that each array will have a life of about nine months. While two arrays are being gasified other arrays will be in course of preparation, so that they may be brought into use as previous arrays reach the end of their useful life.

The pilot plant is being laid out to give much experimental information, and will, therefore, be instrumented on a far wider scale than would be necessary for a full-scale commercial plant. Furthermore, it is pointed out that, with a full-scale plant, longer galleries and bore-holes would be used with more widely spaced shafts, so that the disturbance to the countryside by a commercial plant would be very much less than in the case of the present pilot plant.

A complementary and important side of these experiments is the development of techniques for directional drilling of bore-holes to follow seams of coal, and this work is being carried out under particularly suitable conditions in a disused part of the nearby Oxcroft colliery. To date, some excellent results have been achieved in drilling long bore-holes, reaming them out to 12-in. diameter, and in directional control following the course of a seam.

RECENT Equipment AND Accessories

The measurement of steam flow

The Kent RS/C shunt meter is a simple and inexpensive means of measuring steam flow. It comprises a main body, top cover, cooling chamber and damping chamber. Within these components are the actual working parts of the meter, consisting of turbine-shaft assembly, reduction train and driving magnet. Secured to the main body are the orifice and nozzle plates. Also situated at the lower end of the shaft is the damping fan which rotates in water, normally filling the damping and cooling chambers. Below the damping chamber and separated from it by the casting is the counter box, containing the following magnet and gear train for the six-dial counter. The fluid flow tends to pass straight through the body until it meets the orifice-plate restriction which causes a differential pressure to develop across the meter, inducing a proportion of the flow upwards through the nozzles to impinge on and rotate the turbine before continuing through the shunt passage, and then to the meter outlet. Turbine rotation is controlled at a speed proportional to the by-pass flow by the action of the damping fan rotating in water. As the by-pass is proportional to the main rate of flow, the rotary speed is a measure of the total flow. The rotary speed is reduced by the reduction train, located below the damping chamber, the final stage of which is coupled to the driving magnet. The two magnets lock into step and enable the turbine rotation to be totalised on the counter in units of flow. For horizontal pipes of 2-in., 3-in. or 4-in. dia., the meter is bolted directly between the flanges of the main, while for horizontal mains above 4-in. dia. and for vertical mains, a master orifice plate is inserted between the flanges of the main and a by-pass carrying a 2-in. meter is screwed or welded into the wall of the main at specified distances from the plate. The differential pressure created by this master plate forces a proportion of the flow through the by-pass to the meter. (*George Kent Ltd., Luton, Bedfordshire.*)

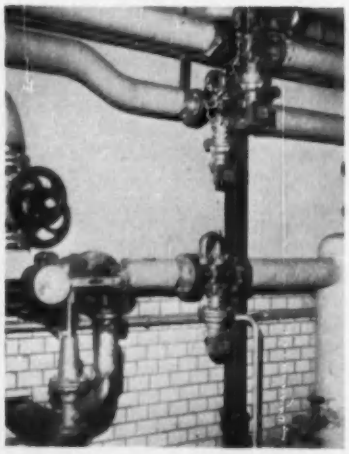


Fig. 1 (left). An installation of three RS/C shunt meters measuring steam in the chemical division of a Danish meat canning factory. (George Kent Ltd.)

Multi-point control valves

Where a number of main control valves are used in the construction of pneumatically or hydraulically operated machinery, a problem may arise in providing inter-connecting piping for supply and exhaust connections. A neat and economical solution can be found by grouping the control valves at a central point in such a way that these interconnections are eliminated, and Baldwin Instrument Co. Ltd. have now introduced such a system, for applications to the low-pressure fluid power field. The valves, which may be fitted with manual, mechanical, electric solenoid or pilot operating mechanisms, are supplied as a multi-point "packaged unit" embodying any number of valves, up to a maximum of 12. The supply and exhaust ports of all the valves are led into passages running the full length of the assembly, screwed connections being provided in special end pieces, which also provide facilities for mounting the assembly as a whole. Each end block contains one supply and one exhaust tapping, which are common to all valves. Tappings in each individual valve body provide fluid take off points for solenoid pilot heads, where these are used. Each main control valve is, therefore, an entirely independent unit from the functional point of view. This facilitates servicing and also dispenses with separate pilot supply piping. To install the unit, it is necessary only to connect the main air or oil supply to one end block, and lead the usual connections to each power cylinder. For pneumatic service, protective hoods are fitted to the main exhaust ports of any solenoid pilot mechanisms which may be incorporated. For hydraulic service, the user must provide one drain line only back to the pump reservoir, solenoid drains being fitted internally in each valve element. At the present time, these "packaged units" are available in the ¼-in. bore 4-way pattern only. (*Baldwin Instrument Co. Ltd., Brooklands Works, Dartford, Kent.*)

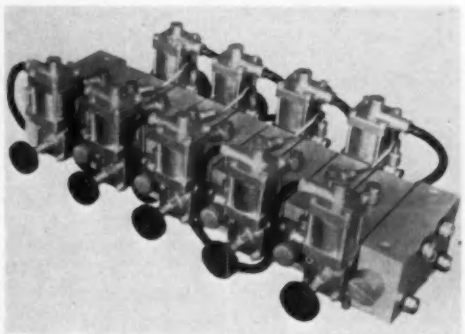


Fig. 2 (right). The Baldwin multi-point solenoid valve "packaged unit." (Baldwin Instrument Co. Ltd.)

A new type of flash-evaporator

A new type of flash-evaporator for the production of high purity distilled water from sea-water has been developed by Richardsons Westgarth & Co. Ltd., who claim that the main advantage of this new unit is that by the adoption of an entirely new approach to design and operation they have been able to reduce the overall size of the plant, which is, in fact, contained in a single vessel. The result is a considerable saving in space and cost, while at the same time a large amount of external pipe-work is eliminated. The new evaporators, which can, if required, be arranged for semi- or fully-automatic operation, are available for any duty within the following range:—

Net gained output of distilled water —10,000-500,000 lb./hr.

Net gained output ratio—2 : 1-7 : 1 (lb. of distillate per lb. of steam).

The unit is designed for heating by any low-grade steam supply available, 11 lb./sq. in. being the lowest economical pressure. The output figures quoted are, the company say, based on long periods of operation and thorough research work on a large test-rig, using sea-water as the raw feed, but the evaporator is equally suitable for distilling softened water when higher operating temperatures can be used, with consequent higher outputs from a given size of evaporator, and, of course, reduced costs. The prevention of scale is a most important aspect in industrial sea-water evaporators, and all the development work on this new unit was carried out by treating the sea-water feed with 5 p.p.m. of "Hagevap LP" (supplied in this country by Albright & Wilson). The slight deposit produced in the tubes, after prolonged operation using this treatment, is in the form of a thin layer of soft sludge, and means are provided for washing this away without interrupting the operation of the evaporator. (*Richardsons Westgarth & Co.Ltd.,Wallsend-on-Tyne.*)

Thermocouple wire

A new type of thermocouple wire is now available from Philips Electrical Ltd. This has been specially designed for measuring a wide range of temperatures. Four different types are available for temperatures from 200 deg. C. up to 1,000 deg. C., with ceramic-packed single or double core in a metal sheathing. Diameters vary between 0.5 mm. and 1 mm. according to type. The wire can be bent to a curve having only five times the wire diameter and into any configuration without risk of earthing or shorting the cores. The material has extremely low heat capacitance at the hot junction and, therefore, a high response sensitivity. Suitable for high-pressure working conditions, it requires no additional insulation, is simple to instal and is particularly suitable for multi-point measurement where space is limited. (*Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.1.*)

Springs for constant support hangers

The considerable lengths of piping and ducting used throughout power stations are subject to large degrees of movement by expansion under the influence of extremely high temperatures. It would, for example, not be unusual for a large mass, such as a valve or other component, weighing over 10 tons to be moved several inches vertically, on the main gas pipeline of a nuclear power station. To counteract this, a form of spring balance, a constant support hanger, is used to relieve the various pipe joint faces of the greater portion of the weight of the pipe itself, and of such components as valves. It is, however, essential that the load and effect supplied by the spring balance be constant at all times, and under all conditions. The accompanying illustration, shows some of the springs made for this purpose by Geo. Salter & Co. Ltd., nearly 4-ft. high and 1-ft. dia., the slightly heavier springs, which are easily distinguishable, having a bar diameter of 1⅛-in., and a bar length of 46-ft. in 16 coils. Springs supplied by Geo. Salter are incorporated in constant support hangers manufactured by Vokes Genspring Ltd. (*Geo. Salter & Co. Ltd., West Bromwich.*)

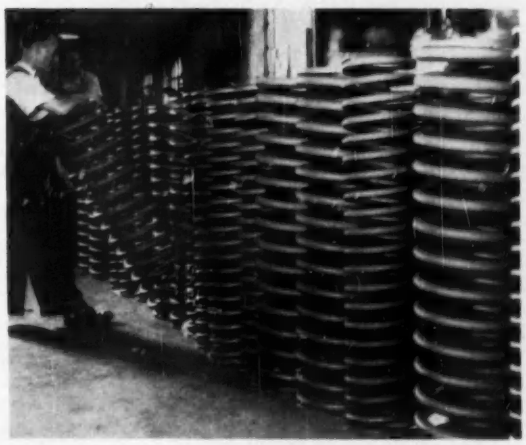


Fig. 3. Springs nearly 4-ft. high manufactured by Geo. Salter for Vokes Genspring constant support hangers. (Geo. Salter & Co. Ltd.)

Rust prevention coating for high-temperature applications

A new metal coating material, "Glostack," specially formulated for the protection against rust of chimney stacks, furnace doors, and other steelwork subjected to high operational temperatures, is now available from Corrosion Ltd. It may be applied by normal painting techniques, and does not require the addition of any hardener, accelerator or curing agent. "Glostack" is touch dry in approximately two hours, after which time treated plant may be put back into service. The coating is said to remain stable throughout a wide temperature range, from normal atmospheric temperatures to an upper limit of over 800 deg. F., while a further important feature emphasised by the manufacturers is that it has good weather resistant properties, and will also withstand attack by chemical fumes of the kinds normally experienced in the vicinity of gasworks, electricity power stations, chemical works, etc. (*Corrosion Ltd., 16, Gloucester Place, London, W.1.*)

Flame-failure equipment

A range of Fireye flame-failure safeguard equipment is now being manufactured in this country by the Fireye Controls Co. Ltd. These units operate on the principle of monitoring a flame by detecting the infra-red emanation from that flame. The equipment consists of two units—a lead sulphide cell scanner and the control which registers the existence (or otherwise) of the flame and passes on impulse to initiate the establishment of safe conditions after flame-failure has occurred. With a multi-burner installation, each burner requires to be individually monitored, and the company point out that experience has shown that a relatively high degree of protection can be obtained with a boiler having up to 24 burners. The Fireye equipment can be arranged to provide varying degrees of protection as follows :—(1) alarm only ; (2) alarm plus shutting-off of fuel ; (3) alarm plus shutting-off fuel plus safe light-off ; and (4) an integrated system. Under system (3) the safe light-off protection is achieved by incorporating a push-button, indicating-light unit which proves to the operator that the pilot flame, hand-torch or swab is in the correct position, and of a correct size to light-off the main flame satisfactorily. The integrated system by the additional inclusion of purge interlocks, delay relays and other timers is formed into an integrated panel system of control, for installations fired by either gas or oil. Fireye flame failure safeguards are, the company say, particularly adaptable in that conventional interlocks,

such as those for f.d., i.d., low-water level, low fuel oil temperatures, low fuel gas pressure, etc., can be incorporated in the control unit to prohibit lighting-off or, after starting-up, to effect a shut-down if such interlock requirements are not met. (*Fireye Controls Co. Ltd., 14, Fetter Lane, London, E.C.4.*)

Solids flow failure device

Bailey Meters and Controls Ltd. have developed a transistorised electronic solids flow failure device to provide a visible and/or audible warning when the free flow of material in an enclosed pipe or chute is arrested. The unit in its present form has been designed to operate with coals, but the company claim they are confident that it can be successfully applied to other solids. The device comprises a 1¾-in. dia. mild-steel probe which projects about ½-in. into the coal pipe, and with a vibration pick-up attached to that part which extends outside the pipe. The output from the pick-up is fed to a four-stage amplifier utilising junction transistors with a relay stage incorporating a time delay. Long cable runs between the probe and the amplifier should, if possible be avoided, and in any case should not exceed 200-ft. The company say that the amplifier has operated successfully at ambient temperatures up to 120 deg. F. (50 deg. C.), but that the actual limiting temperature has not yet been determined. The maximum operating temperature of the probe is determined by the pick-up, and must not exceed 212 deg. F. (100 deg. C.). Investigations into the sizing of coals used at C.E.A. power stations have, the makers claim, shown that the coals normally used are of sufficient size to produce an adequate signal with the standard type of probe. If, however, extremely fine coals are encountered, a special probe, extending 6-in. into the pipe is available. (*Bailey Meters & Controls Ltd., Purley Way, Croydon, Surrey.*)

Refractory protective coatings

Coltrate Ltd. have introduced a new range of refractory protective coatings for furnaces, under the trademark "Coltrate R.P.C." The range includes several types to deal with varying conditions. These are all supplied in the form of a dry powder, which is mixed with water, and applied by brushing, spraying or trowelling, the recommended coating thickness being from $\frac{1}{16}$ to ¼-in. Following application of the coating, the furnace is fired, and the temperature steadily increased up to a point where vitrification of the coating takes place. It then remains, the company says, as a strong, continuous, monolithic lining, that prevents cracking of the underlying refractories. The coating also penetrates and seals the pores of the refractories, and forms a barrier to gases and particles. It is also claimed that the coating provides a gas-tight seal with a resultant saving in fuel and higher operating efficiency, while it also resists slagging and is not readily wetted by slag. The complete range of Coltrate R.P.C. (glazed types) covers the temperature range 1,500 to 3,000 deg. F. A non-vitreous type (Nonvit) is also available for the complete temperature range from 50 to 3,500 deg. F., and also a refractory mortar for bonding, patching and plugging, designed to be effective over the temperature range up to 3,000 deg. F. (*Coltrate Ltd., 35, New Broad Street, London, E.C.2.*)

New cylinder-operated valves

A range of cylinder-operated valves introduced recently by Hunt & Mitton Ltd. have been designed for working pressures, using saturated steam, of up to 300 lb./sq. in.; with superheater steam up to 250 lb./sq. in. at 500 deg. F.; and with oil or water up to 500 lb./sq. in. at 150 deg. F.

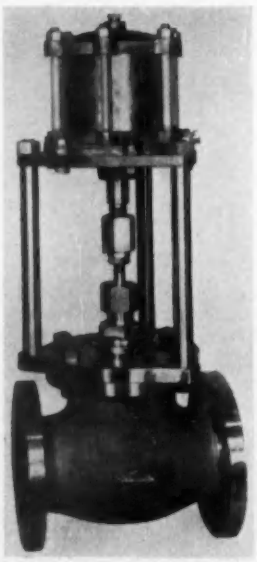


Fig. 4. A model from the Hunt & Mitton new range of cylinder-operated valves. (Hunt & Mitton Ltd.).

The valve bodies are of the globe pattern manufactured from a bronze casting and are complete with a bolted cover, renewable Nickloy valve discs and seats, and a strong section stainless steel spindle. The cylinder is secured to the valve cover by heavy mild-steel pillars. The cylinders are suitable for pneumatic operation, and require air at 60/110 lb./sq. in.; they may be single-acting with spring return, or double acting. They are available in sizes from 1 to 4-in., with flanged connections to B.S.T. "E," "F" or "H"; and may be supplied as either "air to open" or "air to close." (*Hunt & Mitton, Oozells Street North, Birmingham, 1.*)

Extended range of piston valves

The Richard Klinger Ltd. range of air-operated piston valves has now been extended to the use of hydraulic operation. Previously designated "Klingerflow," the valve bodies have now been standardised for operation by either compressed air or hydraulic power, and both systems are now recognised by the trade-mark "Klingermatic." The hydraulic system for these valves is specially constructed by Lockheed, and complete installations can be made in accordance with any desired requirement. The hydraulic fluid is contained in a one-gallon supply tank, which is located in the top of the cabinet. The fluid passes through a needle valve to the pumps. In the base is a small electric pump with pressure-gauge attached, but alternatively there is a four-cylinder transmitter (duo-directional pump) operated by the large handwheel on the face of the cabinet for manual control. The motor pump passes the hydraulic fluid to a blow-off valve which, if the cylinders are not being operated, returns the hydraulic fluid to the supply tank. When operating the hydraulic cylinders, the fluid flows from the four-cylinder transmitter or the electric pump via automatic change-over valve to a metering and reversing valve, which is also used as a switch for the pump unit. The metering and reversing unit then passes the fluid to the selector valves. (*Richard Klinger Ltd., Sidcup, Kent.*)

A new air filtration unit

The "Rollotron" air filter, a new unit available from Air Control Installations Ltd., combines a dry-plate electrostatic precipitator with an automatically renewable filter media. The ionising unit of the precipitator consists of electrodes of fine tungsten wires, 0.008-in. dia., uniformly spaced between parallel grounded struts. With 12,000-V direct current applied to the ionising wire, a strong field is set up between the wire and grounded struts. Dust and smoke particles passing through this field intercept streams of ions travelling from the wires to the struts and acquire a surface charge of

searches into materials for use in reactor construction which will be carried out at Lucas Heights, allied research programmes will be undertaken at Australian Universities. For example, the N.S.W. University of Technology is constructing a solar furnace for investigating the production of materials capable of withstanding the temperatures met with in nuclear power plants. The furnace will consist of a mirror 12-ft. in dia., mounted on a 65-ft. plywood tower, and it will be capable of producing temperatures of over 4,000 deg. C.

Geothermal steam in New Zealand.—The Tasman Pulp and Paper Co. Ltd., of Kaweran, N.Z., is using high-pressure steam from wells drilled to depths of about 2,000-ft. for heating timber-drying kilns and for driving machinery in their wood preparation room. The company dries about 25 million board feet of timber annually, and its kiln installation is the largest in New Zealand. The eight steam wells adjoining the mill site are producing 350,000 lb. of steam per hr. at 150 lb./sq. in. The partial output of any single well is sufficient to provide all the steam for the kilns, the wood-preparation room, and the wood-preservation plant. Further utilisation of the steam is projected. At the well head the steam passes through a steam trap and then enters a 3,400-ft. long, 12-in. steam line. At the mill the pressure is reduced from 150 to 50 lb./sq. in. before being used for process work. Normal oil-drilling techniques were used in sinking the steam wells. The prospecting work was undertaken by Fletcher-Bechtel-Raymond Engineering Services, a joint venture of the Fletcher organisation of Auckland, the Bechtel Corporation of San Francisco, and the Raymond Concrete Pile Company of Delaware. It is stated that the actual drilling work was sub-contracted to the Brown Drilling Co., which has also been drilling for oil in Western Australia recently.

A large mobile exhibition of **George Kent Ltd.** products is now touring Europe, where it will be available for demonstrations at customers' works, and to participate in exhibitions arranged in connection with technical conventions. Coach-built on a lengthened Dodge chassis and powered by a 4.73-litre diesel engine, the vehicle has an overall length of 32-ft., is 12-ft. high, 8-ft. wide, and has a kerb weight of approximately 7-ton. It will contain a comprehensive range of instruments to cover most industrial applications. Several of the Commander range, including the new electronic KE, will be shown, together with Multelec instruments. A sectioned RS/C steam-flow meter and M2 water meter will also be on show, with a CM water meter, CM low-flow oil meter, unit-type draught gauges, Universal pH primary elements, and a display unit of small Dall and Venturi flow tubes and orifice fittings. A small electric furnace has been included for use with temperature-recording instruments. A number of the firm's aircraft-fuel meters are also being displayed, as well as a variety of miniature electric motors for the scientific industries. Beneath the floor of the vehicle, a mains-driven air-compressor plant has been installed to supply the air-operated control instruments, and also a 24-volt battery-driven rotary generator for a stand-by electricity supply. Where a mains supply is available, this can be connected either direct or *via* the 110/230-volt transformer mounted in a separate switchgear compartment above the driving cab. While running on the mains supply, both the vehicle batteries and the additional ones carried for the rotary generator can be charged through a battery charging unit.

(Below). Exterior and interior views giving some idea of the scope of the George Kent Ltd. mobile exhibition which is now touring Europe.

Mr. L. C. Percival, chief metallurgist of the British Oxygen Group of Companies, has been appointed president of the North London Branch of the Institute of Welding. A founder member of the branch, he previously held the office of president from 1949-50.

* * *

The Incandescent Heat Co. Ltd., Smethwick, Birmingham, have issued a new leaflet (No. V51) entitled "Incandescent-Laclede Interchangeable Suspended Arch." The leaflet gives useful technical information on the arch which is designed for duty with high-temperature conditions in open hearth, re-heating and other furnaces. Incandescent-Laclede Arches are built under licence from the Laclede-Christy Company, a division of the H. K. Porter Company Inc., U.S.A.

A 60-page booklet describing the La Mont system of forced and controlled recirculation, and its application in the various fields of steam generation, was published recently by **La Mont International Association Ltd.,** 42, Leicester Square, London, W.C.2. The first half of the booklet discusses the advantages of forced and controlled circulation and gives details of the construction and operation of La Mont boilers, while the second half contains a selection of diagrams and photographs of some typical installations. There are, in fact, nearly 80 line and half-tone illustrations.

Lancashire Dynamo Electronic Products Ltd., Rugeley, Staffordshire, announce that the British Standards Institution have granted licences covering the use of the B.S. "Kite" mark on their smoke alarm and density indicator series SME2. The equipment, described in the November, 1957, issue of this journal, meets the requirements of both B.S. 2740 : 1956 covering smoke alarm and alarm metering devices and B.S. 2811 : 1957 covering smoke density indicators and recorders (provided that with B.S. 2811 an approved indicating meter is used with the equipment). This means that a smoke alarm installed to meet the requirements of the Clean Air Act can be converted to a smoke density indicator, and provide a simple form of combustion control.

OVERSEAS Steam Engineering Practice

Abridgments of recent articles in the colonial and foreign technical press, concerning design and progress in the technique of steam generation and power plant equipment

Increased steam-generating capacity for paper manufacturing plant

The original steam generating capacity of the Blandin Paper Co., of America, comprised a Foster Wheeler boiler rated at 65,000 lb./hr. at 450 lb./sq. in. and 650 deg. F., and a Babcock & Wilcox integral furnace boiler rated at 100,000 lb./hr. at 450 lb./sq. in. and 680 deg. F. Both these units are pulverised-fuel fired installations. In recent years a second B. & W. boiler has been installed, with a designed capacity of 195,000 lb./hr. at 850 lb./sq. in. and 800 deg. F., which at the present time operates at 175,000 lb./hr., at 450 lb./sq. in. and 700 deg. F. The boilers supply steam to three Allis-Chalmers turbo-alternators, one of 1,875-kVA, and two of 5,000-kVA capacity, while plans are in hand for the installation of a further unit of 10-MW capacity. The stoker associated with the new boiler is a Detroit Rotograte spreader stoker, 21-ft. 1½-in. wide by 17-ft. 8-in. long and capable of burning a wide variety of lower grade coals. Fly-ash from the boiler hoppers and economiser is returned to the furnace for re-firing, while fly-ash from the dust-collector in front of the i.d. fan is ejected to the hopper. The i.d. fan for the new boiler is driven through a magnetic variable-speed coupling by a 350-h.p. motor, and the f.d. fan by a 150-h.p. motor, with inlet vane control. Bailey combustion and three-element feedwater control are installed. It is of interest to note that the company also obtain a portion of their electricity supply from two hydro-electric installations—one of these being actually on the factory site, and comprising two units, an Allis - Chalmers 1,875 - kVA fixed-blade type unit and an 875-kVA Leffel turbine. The second installation situated some six miles from the factory contains one 450-kVA and one 650-kVA generating unit. (*Power Engineering*, Vol. 61, No. 11, pp. 78-80.)

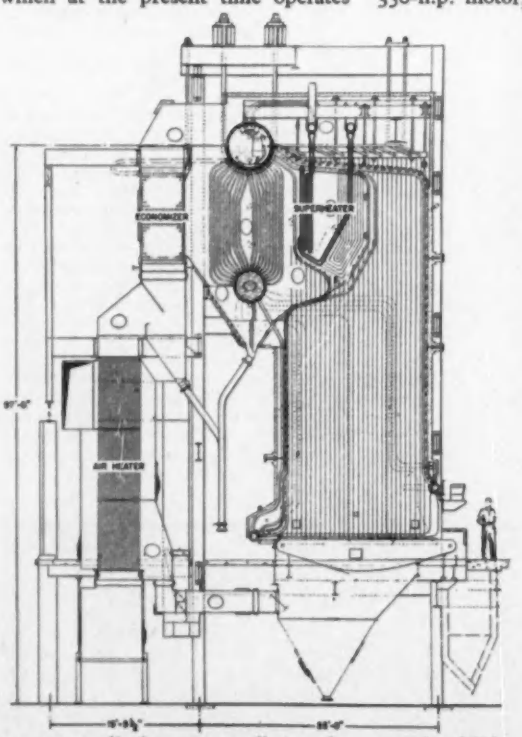


Fig. 1. A cross-sectional arrangement of the new No. 3 boiler installed at the works of the Blandin Paper Co.

Steam temperature control by dampers

The considerable difficulties encountered in the control of high steam temperatures are well known. An investigation was, therefore, made of two Benson boilers equipped with dampers for the control of the reheat steam temperature. The salient data of these two plants are given as follows :—

Installation	(A)	(B)
Live steam:		
lb./hr.	507,150	418,950
lb./sq. in.	2,485	1,917
temperature deg. F.	995	977
Reheat steam:		
lb./hr.	463,000	388,000
lb./sq. in.	541/511	418/410
temperature deg. F.	644/941	635/950

The arrangement of the dampers and the reheater parts influenced by the dampers is shown in Figs. 2 and 3. The respective metal weights of the reheaters and the respective heat absorptions in the parts of the reheaters influenced by the dampers are as follows :—

Installation	(A)	(B)
Control damper after	Reheater	Final evaporator section
Control effected at load, per cent. ...	74	110
Metal weight of reheater tons ...	50	49
Heat absorption of reheater during test giga kal/hr. ...	10.5	15.3

The reheat temperature control characteristics as produced by the damper control are shown in Fig. 4. The upper diagram refers to installation B. The test run was carried out as follows. Firing rate and steam output were constant, the spray-type desuperheater of the reheater was kept inoperative, the reheater dampers were fully open and the final evaporator section dampers were closed. By opening the latter, the gas flow through the reheater was then diminished. The final evaporator dampers were successively positioned at 18, 27, 36, 45, 54 and 63 deg. opening, and after attainment of stable conditions were then closed. The diagram shows that in the range of damper positions from 27 deg. to 54 deg. a satisfactory relationship between damper position and reheat steam temperature exists.

The characteristics of installation A are shown in the diagram to the same temperature and time scale as those of installation B. These characteristics are shown to a larger scale in the lower part of Fig. 4. It is seen that after closing the dampers there was a time lag of 1.7 min. followed by a decline in steam temperature at the rate of 3.8 deg. C. per min. Stable condition is reached after some 26 min. At $t =$ 30 min. the dampers were opened and after a time lag of 1.5 min. the steam temperature rose at the rate of + 4.9 deg. C. per min. (*BWK*, Vol. 9, November, 1957, pp. 531-533.)

Australian fuel notes

New thermal power station for N.S.W.—The N.S.W. Electricity Commission has invited tenders for steam generating plant, costing approximately £A10 million, to serve three turbo-alternators—one of 120-MW capacity at the present Lake Macquarie station, and two, of either 120 or 200-MW, at a new station to be built at southern Lake Macquarie. The steam plant will comprise three semi-outdoor type boilers, each burning 2,000 tons of coal a day. The largest will operate at a steam pressure of 2,450 lb./sq. in. and temperature of 1,055 deg. F. In addition, the Commission is constructing a 30-MW station at Muswelbrook, on the Northern coalfield. C. A. Parsons & Co. Ltd. are supplying the two 15-MW turbo-alternators, International Combustion (Australia) Ltd., the boiler plant, and the principal contractors for the design and construction of the station are Utah Australia Ltd. *Nuclear power.*—The Australian Atomic Energy Commission entertained over 1,000 members of the scientific and engineering institutions on October 19th, 1957, when an Open Day was held at the new research establishment, Lucas Heights, near Sydney. HIFAR, the Commission's experimental reactor, came into operation during December, 1957. It was started on low power (about 5-MW) and will eventually develop 10-MW when working at full capacity. Of similar design to DIDO, the new experimental reactor at Harwell, HIFAR is heavy-water-moderated, and has a thermal neutron flux of 10^{14}/cm^2/sec. The primary coolant is heavy water, the secondary coolant ordinary water. The heat is finally dissipated in wooden cooling towers. The water used for cooling purposes does not become radioactive. The neutron reflector consists of 60 cm. heavy water plus 60 cm. of graphite. The fuel for the reactor—5 lb. of uranium 235—is being transported from Britain by air in several consignments. The heavy water is being purchased from the U.S.A., at a price of about £A10 for a teacupful. Heavy water is circulated continuously through the fuel elements, which consist of alternate layers of uranium and aluminium alloy, forming an approximate cylinder 60 cm. in length and 86 cm. equivalent diameter. Surrounding the reactor is a biological shield consisting of a 5-ft. thickness of barytes concrete. The main contractors for the construction of the reactor were Head Wrightson Processes Ltd., and International Combustion (Australia) Ltd. were the sub-contractors for the erection of the reflector. More than 800 blocks of nuclear - grade graphite, weighing about 30-tons, have been successfully machined in Australia and assembled at the site. The Commonwealth Minister for National Development recently said that the work had been completed ahead of schedule, and it was a tribute to the technical skill of Australian workers and managements. Besides the extensive re-

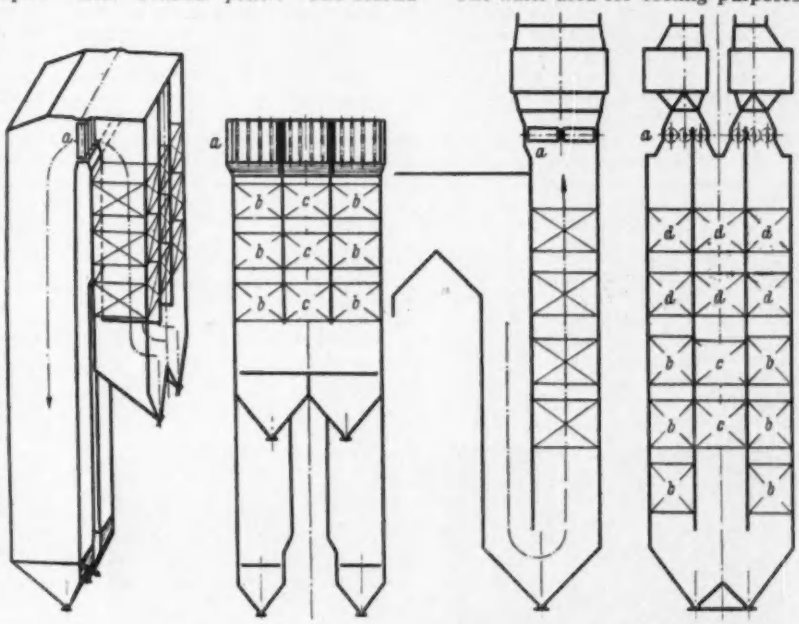


Fig. 2 (right) and Fig. 3 (extreme right). Arrangement of dampers and reheater parts influenced by the dampers. KEY:—a, dampers; b, reheaters; c, final evaporator; d, feedwater heater.

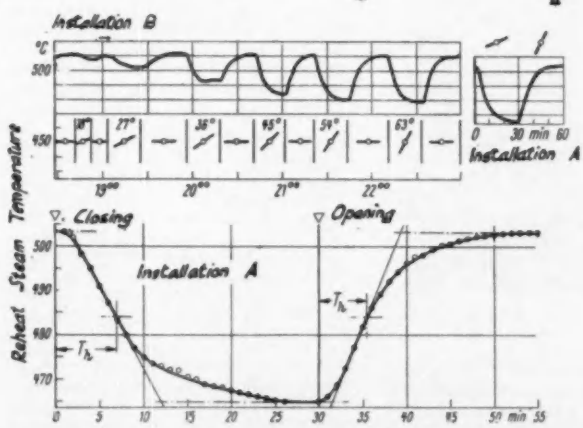
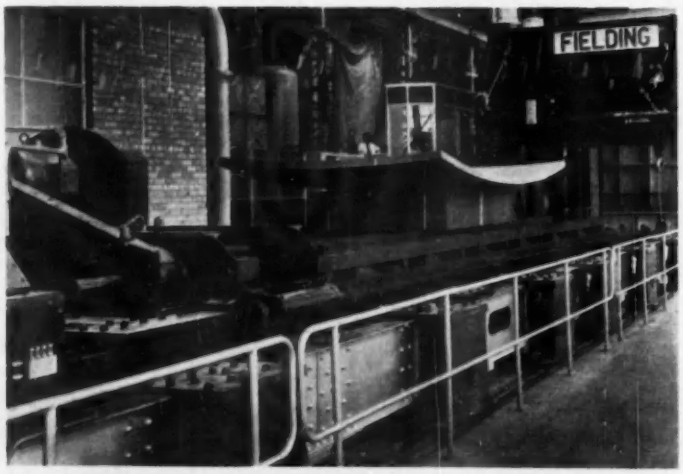


Fig. 4. Graphs showing reheat temperature control characteristics

definite polarity. Leaving the ionising unit, the charged particles enter the collector (agglomerator) element. The collector element consists of closely-spaced parallel metal plates alternately charged and grounded to maintain a uniform electrostatic field. The charged dust particles are repelled by plates of the same polarity and attracted to plates of opposite polarity. They agglomerate by adhering to one another, and when the particle build-up becomes great enough, the accumulation is carried by the air stream on to the filter media of the storage section. The storage section is completely automatic in operation. The renewable media filtering curtain (mounted in roll form at the top of the unit) moves down the face of the filter and is re-rolled at the bottom with its dust load. Movement of this curtain is controlled by an automatic timer switch which introduces sufficient clean media to maintain operating resistance at a desired level. The filter media, "Roll-O-Mat," consists of bonded glass fibres, precharged with a specially-developed viscosine which, the company say, retains its jelly-like consistency under a wide range of temperature and humidity conditions. A 65-ft. length of this material, which is capable of being compressed to paper thinness, measures only 13-in. dia. on the roll. Maintenance involves simply re-placing the soiled media roll with a new one—an operation which can be compared with changing a film in a camera. "Rollotron" units are available with capacities from 4,500-94,600 cu. ft./min. (*Air Control Installations Ltd., Ruislip, Middlesex.*)

WHESSOE LTD. INSTALL NEW PLATE PRESS

A special press for shaping heavy steel plates has been put into service at the Darlington works of Whessoe Ltd., where among other operations it is used to form the 3-in. thick plates for the reactor vessels which the company are constructing for the Bradwell nuclear power station of the Central Electricity Authority. Whessoe Ltd. are, of course, members of the Nuclear Power Plant Co., who are responsible for the design of this station. The press, which operates hydraulically and incorporates automatic controls, was built by Fielding & Platt Ltd. and is capable of handling the largest plate produced in this country at the present time, with a substantial margin in capacity should larger plates be available at some future date. Associated with the press is a plate-heating furnace and charging machine supplied by Gibbons Brothers Ltd. Two special purpose shops were built at the same time, and in the first of these the plates formed by the press are marked by means of a light-projector plant—a system that has taken the place of "marking-off," until now the universal practice in steel-plate engineering and shipbuilding. The plates are cut to shape and prepared for site welding in the second shop, by means of an automatic flame-cutting plant. These shops with their equipment, together with the press and its associated plant, must form one of the most advanced installations for the preparation of plates for spherical high-pressure vessels.



The furnace charging machine and plate press recently installed by Whessoe Ltd. to form the 3-in. thick plates for nuclear power station reactor vessels.

W. H. Allen Sons & Co. Ltd., Bedford, have received a contract for the construction of steam-turbine-driven generating sets in connection with the nuclear submarine, H.M.S. *Dreadnought*, to be built by Vickers-Armstrongs Limited. Units will be installed at Dounreay for shore tests and others in the ship. The turbo-generators incorporate electrical equipment supplied by the British Thomson-Houston Co. Ltd. The condensers, which are separate from the turbo-generators, will also be supplied by W. H. Allen Sons & Co. Ltd.

It is announced that the **Reactor School at Harwell** is to increase the number of courses to be held each year. Four standard courses will be held instead of three, each lasting sixteen weeks, and there will also be two courses for senior technical executives each lasting nine days. The fee for a standard course is £250 and for a senior technical executives' course £50. These fees do not include accommodation, although the U.K. Atomic Energy Authority will be ready to assist in making bookings. The dates of the courses are :—*Standard Courses* :—January 13th-May 8th ; April 14th-August 1st ; September 1st-December 23rd, and October 27th-February 20th, 1959. *Senior Technical Executives' Courses* :—May 12th-May 22nd ; September 22nd-October 2nd. Further details may be obtained from : **The Principal, Reactor School, Atomic Energy Research Establishment, Harwell, Didcot, Berks.** The latest time for receipt of applications is three months before each course begins : the January course has already been filled.

* * *

The Central Electricity Generating Board have appointed **Mr. H. B. Morton,** assistant legal adviser to the Central Electricity Authority, to be deputy solicitor. Mr. Morton joined the legal staff of the Central Electricity Board in 1929 and was appointed deputy solicitor of the Board in 1944. Upon nationalisation of the electricity supply industry in 1948, he took up his present post with the Authority.

* * *

A new oxygen compressing station is being built by **British Oxygen Gases Limited,** at Durranhill Industrial Estate, Carlisle. The building, which is erected upon a site of nearly two acres, is leased from Carlisle Corporation, and in addition to compressing oxygen into cylinders, it will serve as a distribution centre for the company's range of industrial gases.

* * *

Dewrance & Co. Ltd., Great Dover Street, London, S.E.1, have made available four new catalogues. These deal respectively with Dewrance-Ashcroft Duragauges (No. 690) ; Dewrance Consolidated safety valves for marine service (No. 691) ; Dewrance "Stuf-Line" valves (No. 692) ; and the Dewrance-Ashcroft lapping machine for parallel slide-valves (No. 693).

Latest Power Plant Patents

These extracts from British Patent Specifications are reproduced by permission of The Controller of H.M. Stationery Office. (Complete British Specifications can be obtained from the Patent Office, 26, Southampton Buildings, London, W.C.2. Price 3s. 6d. each, both inland and abroad.)

Forced recirculation waste-heat boiler

This invention relates to forced recirculation steam boilers in which the flow of water through the boiler tubes is maintained by a circulating-pump. Waste-heat contained in waste gases from all types of industrial furnaces, or exhaust gases from internal combustion engines, or gas turbines is utilised for heating the boiler surfaces. The invention has for its object an improved arrangement for isolating and controlling the water flow to groups of tubular elements. The system is used in a forced recirculation steam boiler, the heating surfaces of which are divided into groups of tube elements capable of being isolated on the water side and so arranged that each group of elements is connected independently by means of a pipe line to the circulating-pump discharge, and that isolating valves are fitted into the individual pipe lines for isolating each group of elements from the circulating boiler water flow. To facilitate operation and control of the isolating valves in the pipe lines to the groups of elements, these are arranged adjacent to the circulating pump discharge. The invention can be applied to waste-heat steam boilers of the circular-type in which the heating surfaces are formed by a number of spirally-wound tube elements. It can also be applied to a waste-heat steam boiler with square or rectangular cross-section in which sinuous tube elements are arranged in parallel. Fig. 1 illustrates diagrammatically a circular-type waste-heat boiler (1) with groups of tube elements (3, 4, 5, 6 and 7), and a distributing header (8) divided into compartments (9) corresponding to the number of tube groups. The tube elements which emanate from the compartments (9) of the distributing header (8) are connected to the common collector header (10), which, in turn, is connected by pipe (11) to the steam and water drum (2). The boiler water is drawn from the steam and water drum (2) through pipe (12) by the circulating pump (13) and discharged through delivery pipe (14) to the individual pipe lines (15), which connect to the compartments (9) in the distributor header (8). The isolating valves (16) are arranged at the beginning of the pipe lines (15), and are positioned for easy operation from the circulating-pump control platform. By closing valves (16) the individual tube groups can be isolated and steam output can be regulated in accordance with demand. The gas flow through the boiler is in the direction of the arrow (*B*). Fig. 2 shows diagrammatically a square-type waste-heat boiler (17) with tube groups (18, 19 and 20), and distributor header (21) divided into compartments (22). The tubular elements emanate from the compartments (22) of the distributor header (21) and are connected to the collector header (23). The boiler water is drawn from the drum (24) through pipe (25) by the circulating-pump (26) and is discharged through delivery pipe (27) to the individual pipe lines (28); the flow quantity to the individual pipe lines (28) being regulated by valves (29). The boiler water passes through the heating surfaces, tube groups (18, 19 and 20) absorbing heat, discharges into collector header (23) and returns via pipe (30) to the drum. *British Patent No. 786,412 issued to H. Vorkauf. Application in Germany made on April 13th, 1956. Complete specification published November 20th, 1957.*

Fig. 1 (right). British Patent No. 786,412.

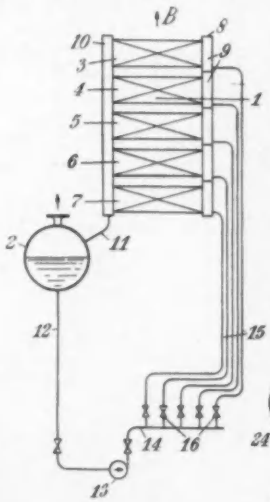
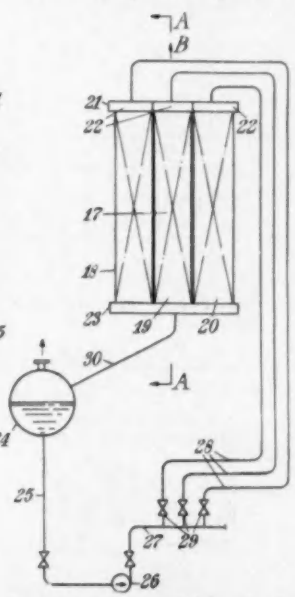


Fig. 2 (extreme right). British Patent No. 786,412.



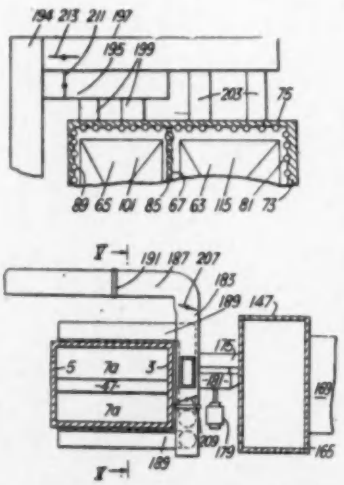
Boiler with gas recirculation

This invention relates to steam boilers incorporating a gas recirculating system whereby it is possible to vary the ratio of heat absorbed for superheating to heat absorbed for steam generation, and/or to limit the gas temperature within the furnace of the unit, or at a region adjacent to the outlet from the furnace. A unit of this type is sometimes provided with parallel passes containing superheating and reheating surfaces respectively; and it is also fitted with damper arrangements whereby the distribution of gas flow between the passes, and, therefore, the degree of superheat and reheat over a wide range may be controlled. In practice, however, the use of such damper arrangements for the purpose of controlling superheat and reheat over a wide range has the disadvantage that it increases the loading of the forced and induced draught fans, since when changes in load occur any increase in draught loss at the dampers has to be provided for by the fans. Referring to the boiler shown in Figs. 3, 4 and 5, saturated steam from the drum (17) flows through pipes (79 and 97) to the respective inlet headers (77 and

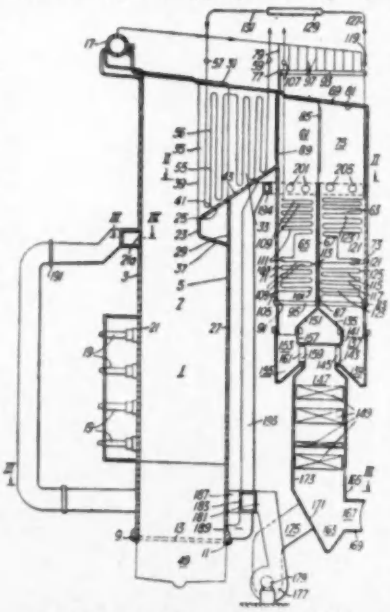
93) of the cage of superheater tubes upon which the gas turning chamber (61), and the downpasses (63 and 65) are based. After passing downwardly through the tubes of the cage the steam reaches the transfer headers (83 and 87) from which it flows upwardly through the primary superheater (115) to the outlet header (119). The steam then passes into pipe (127) and to the spray-attemperator (129). From the attemperator the superheated steam flows through pipe (131) to the inlet header (57) of the secondary superheater (55), and through that superheater to the outlet header (59), from where it passes to the steam turbine. Steam leaving the high-pressure stage of the turbine is returned for reheating to the unit, and enters the reheater inlet header (105), passes through the tubes of the reheater (101) to the outlet header (107) and then returns

Fig. 3 (right). British Patent No. 786,962.

Figs. 4 and 5 (below). British Patent No. 786,962.



to a low-pressure stage of the turbine. When operating at low loads, a relatively high degree of reheating is required. It follows that, as compared with the degree of superheating required, less reheating is needed at higher loads than at lower loads and conversely. A convection reheater, however, gives a rising temperature load characteristic. At higher loads, therefore, the temperature of reheat must be limited. Such limitation may be effected by delivering in controlled amounts recirculated gases to the reheater downpass (65), through the ducts (193 and 195) and from there through the conduits (199) and ports (201). In this manner the mean temperature of the gases flowing through the reheater pass (65) is reduced so that the heat transfer to the steam flowing through the reheater is lessened to an appropriate degree,

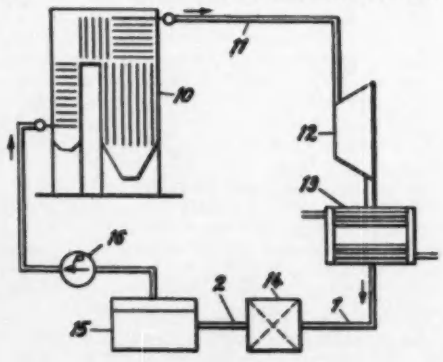


and the desired temperature of reheat is obtained. The flow of recirculated gases to the reheater pass (65) is effected by opening the damper (211), the damper (213) being in the closed position. There occurs, therefore, through the primary superheater pass (63) an increased flow of gases, the temperature of which has not been reduced by recirculated gases introduced to the top of the primary superheater pass (63). The final temperature of superheat, therefore, tends to rise, but the rise is limited to a desired degree value by the appropriate degree of attemperation. On the other hand, as the load falls from full load, and the temperatures of superheat and reheat fall, the temperature of reheat tending to fall more rapidly than that of superheat, recirculated gases are introduced in controlled quantities into the furnace. This is effected by opening the damper (209) so as to lower the temperature in the chamber (1) and thereby increase the proportion of the total heat which is available for superheating. In this manner the superheat and reheat temperatures are increased. Moreover, since over a load range below full load the temperature of reheat is too low, recirculated gases are introduced into the top of the parallel pass (63) containing the primary superheater by way of ports (205) by opening the damper (213), whilst the damper (211) is in the closed position. In this way an increased proportion of the gases flowing to the downpass (63 and 65) from the furnace chamber (1) traverses the reheater downpass (65), and the temperature of reheat relative to that of superheat is correspondingly raised. At loads in the neighbourhood of full load, recirculated gases may be delivered by way of the duct (187) and ports (53) to an upper region of the furnace chamber (1) in order that the gas temperature at the outlet of the furnace may be limited for the purpose of avoiding deposits of slag in sticky condition on the tubes of the secondary superheater (55) or of overheating them. *British Patent No. 786,962 issued to Babcock and Wilcox Ltd. Complete specification published November 27th, 1957.*

Fig. 6. British Patent No. 787,099.

Control of Salt Deposition in forced-flow boilers

This invention relates to a method of controlling the deposition of salts in the tube systems of forced-flow steam generators which normally operate at, or above the critical point of the working medium, whereby the deposition of salts is either eliminated or caused to occur at predetermined places in the tube system. According to the invention, the feedwater is subjected to a total salts elimination treatment so that its residual salts content after the treatment consists predominantly of a compound, or compounds of ammonium. This treatment reduces the salts contents



of the feedwater to a very low concentration, not exceeding 0.25 mg. per litre. In Fig. 6 a steam power plant is shown in which there is a forced-flow steam generator (10) supplying a steam main (11) leading to a turbine (12) from which the steam passes to a condenser (13). From the condenser (13) the pipe (1) leads to an ion-exchange plant (14) of the mixed-bed type from which the pure water pipe (2) leads to a feedwater tank (15) connected through a feed-pump (16) with the steam generator (10). The regeneration of the mixed-bed exchange plant (14) is carried out in this installation with ammonium hydroxide. Therefore, the only salts carried forward with the feedwater into the boiler will be traces of ammonium compounds. Since the ammonium compounds, such as ammonium chloride or ammonium carbonate tend to dissociate or decompose more or less completely, it is thus possible to conduct the steam generation in such a manner that there are no longer any salts present which can be deposited in the tube system ; in the case of the presence of residues of ammonium salts any deposition will no longer assume a dangerous magnitude. If, for example, cooling-water should penetrate into the feedwater through a leak in the condenser, or if impurities should enter the feedwater in other ways, any harmful salts will be caught in the ion-exchange plant (14). Thus by suitable treatment of the feedwater the place and character of the salt deposits which occur in the tube system, can be controlled to a large extent. This is especially important at pressures of over 300 atmospheres and temperatures above 600 deg. C. *British Patent No. 787,099, issued to Sulzer Freres S.A. Application in Switzerland made on November 1st, 1954. Complete specification published December 4th, 1957.*

Mr. J. F. Perry has retired from the board of Metropolitan-Vickers Electrical Export Co. Ltd., of which he had, since 1948, been managing director, and concurrently from the board of the parent company, Metropolitan-Vickers Electrical Co. Ltd., of which he had been a member since 1954. Consequent on Mr. Perry's retirement, **Mr. F. R. Mason** has been appointed managing director of Metropolitan-Vickers Electrical Export Co. Ltd., and **Mr. H. F. Bibby** has succeeded Mr. Mason as the Export Company's general manager. Concurrently, Mr. F. R. Mason has been appointed to the boards of Metropolitan-Vickers Electrical Co. Ltd. and Associated Electrical Industries Overseas Ltd. Mr. Mason joined the Metropolitan-Vickers Electrical Export Co. Ltd. in 1948, being appointed principal representative of that company at the Trafford Park works. In 1951 he was appointed to the Export Company's board, and in 1954 became general manager. Mr. Bibby was appointed manager of the company's new office at The Hague in 1946 and was later appointed manager, American Division, of the Export Company in London. He became assistant general manager in August, 1956, and was appointed to the board on January 1st, 1957.

* * *

Charrington, Gardner, Locket & Co. Ltd., distributors of fuel for over 200 years, have been entrusted by Mobile Oil Co. Ltd. with the sale and distribution of Mobil fuel oils in the Midlands, over an area which covers the counties of Derbyshire, Leicestershire, Rutland, Shropshire, Staffordshire, Warwickshire and Worcestershire. Charringtons have established a sales office at Beaufort House, Newhall Street, Birmingham, and a bulk storage terminal at Bedworth. The products which will now be on sale in the Midlands will be the three industrial grades of fuel oil, Mobilfuels Light, Medium and Heavy, and for domestic users Mobilheat and Mobilheat VB.

* * *

To mark the occasion of the twenty-first anniversary of the founding of the company, **Londex Ltd.,** Anerley Works, 207, Anerley Road, London, S.E.20, have issued a small data book, containing details of the products they manufacture, in the field of electrical remote control.

Mr. Teng Chao-ming, secretary general of the Chinese Economic and Trade Mission, recently visited the Wolverhampton works of John Thompson Limited to discuss trade prospects. He was met by Mr. J. H. N. Thompson, deputy chairman and joint managing director, Mr. D. L. Murray, director and secretary, and Mr. E. Phillips, director. Mr. Teng Chao-ming attended a technical discussion on the design and construction of the pressure-vessel which John Thompson Ltd. is building for the Berkeley nuclear power station reactor. Afterwards he made an extensive tour of the company's factories, during which he saw considerable evidence of the extent of John Thompson's participation in Britain's nuclear power plant programme. He was able to see units which the company, as partners in the A.E.I.-John Thompson Nuclear Energy Co. Ltd., is making for the C.E.A. nuclear power station at Berkeley, Gloucestershire. Also included in the tour were visits to John Thompson factories which produce pressure-vessels for the chemical and processing industries, structural steelwork, etc., and also motor chassis and small components for Britain's leading motor car builders.

* * *

A contract for an epicyclic gear designed to transmit 13,000 h.p. has been given to **W. H. Allen Sons & Co. Ltd.** Ordered by **Richardsons Westgarth (Hartlepool) Ltd.,** this gear is for an extra high-pressure steam turbine of advanced design driving a 9,500-kW alternator, for the Steel Company of Wales. The gear will reduce the turbine speed of 9,500 r.p.m. to the alternator speed of 3,000 r.p.m. The gears for both the above contracts will be constructed at the company's new gearing factory, Atlas Works, Pershore, Worcestershire.

* * *

A new edition of the Drayton/Armstrong steam trap manual is now available on application to **The Drayton Regulators and Instrument Co. Ltd.,** West Drayton, Middlesex. This up-to-date version of the manual contains sections on the operation of steam traps, capacity selection and sizing charts for industrial and domestic applications, testing, maintenance and the locating and correcting of nearly all steam trap troubles likely to be encountered.

The Brush Group Limited announce the following appointments : **Mr. J. Calderwood,** M.Sc., at present technical director, Associated British Oil Engines Limited, has been appointed an executive director of The Brush Group Limited. **Mr. Maurice Tattersfield,** A.C.A., F.C.C.S., hitherto managing director of Brush Electrical Engineering Co. Ltd., has been appointed an executive director of the board of The Brush Group Limited. Mr. Tattersfield remains a non-executive director of Brush Electrical Engineering Co. Ltd., Loughborough. **Mr. B. L. Goodlet,** O.B.E., M.A., M.Inst.C.E., M.I.Mech.E., M.I.E.E., hitherto director and chief engineer, Brush Electrical Engineering Co. Ltd., has been appointed managing director of that company. **Mr. R. G. Hooker,** director and general works manager, Brush Electrical Engineering Co. Ltd., has been appointed director and general manager of that company.

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Illinois Stoker & Combustion Company of Great Britain Limited announce that they have appointed **Mr. E. T. Lewis,** of 43, Lulworth Road, Birkdale, Southport, as their representative in Manchester and N.W. England.

* * *

James Gordon & Co. Ltd., Dalston Gardens, Stanmore, Middlesex, have recently published two new leaflets. No. 113 deals with the Gordon two- and three-element feedwater control for water-tube boilers, while No. 130 describes the company's range of pneumatic power operators suitable for large valves, dampers, etc.

* * *

Lancashire Dynamo Nevelin Ltd., Oxted, Surrey, have sent us copies of their recently issued leaflets :—*List LS.* 1800—This list introduces a range of standard alternator control switchboards and feeder panels suitable for ratings up to 2,000 amp. at 650 volts. *List LS.* 40 is a comprehensive illustrated leaflet dealing with the wide range of standard and " purpose design " heavy industrial switchboards and Unifront flush-fronted switchboards for low-tension distribution applications. *List NML* 12 is a four-page leaflet describing the Lancashire Dynamo Nevelin Varionic variable speed drive to provide a wide range of speed for outputs up to 1,000 h.p.

NOTES *Personal* AND *Industrial*

The Secretary of State for Scotland has reappointed **Colonel Sir John Crabbe** and **Sir Ronald Thompson** to be part-time members of the South of Scotland Electricity Board until December 31st, 1960, and **Sir Jackson Millar** to be a part-time member of the board until December 31st, 1958.

* * *

Sir Ernest Smith has resigned from the chairmanship of the Industrial Coal Consumers' Council, an office he has held since the formation of the council ten years ago.

* * *

Mr. R. G. Lewis, formerly general manager of Birwelco Limited and Brown Fintube (Great Britain) Limited, Chester Street, Aston, Birmingham, and a director of Petrochem G.m.b.H., Dortmund, Germany, and of Servotomic Limited, of 175, Piccadilly, London, W.1, has now been appointed a director and general manager of the two former companies.

* * *

Mr. Humphrey Wigan, M.C., M.Inst.Pet., director of Amber Oils Limited and of Amber Pharmaceuticals Limited, has been appointed a director of the Amber Chemical Co. Ltd. (11A, Albemarle Street, London, W.1). Mr. Wigan is particularly concerned with the company's combustive additives and fuel improvers, a new range of which has recently been introduced to the market.

* * *

The Central Electricity Generating Board have appointed **Mr. W. J. Rowland,** F.C.C.S., to be deputy chief personnel officer, and **Mr. E. J. Guinness,** D.S.C., to be deputy secretary. Mr. Rowland has been the deputy director of establishments of the Central Electricity Authority since 1950, having previously been secretary of Nos. 4 and 5 Sub-Areas of the Merseyside and North Wales Electricity Board. Mr. Guinness was appointed an assistant secretary of the British Electricity Authority in March, 1948, and for the past six years has been the Authority's estates officer.

* * *

Ashworth and Parker Ltd. has announced that **Mr. Fred Hamer,** chief engineer, and **Mr. Ansill H. Smith,** works superintendent, have been appointed directors of the company.

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The Central Electricity Generating Board announce the following appointments :—**Mr. W. Usher,** B.A., LL.B., deputy legal adviser to the Central Electricity Authority, has been appointed solicitor. **Mr. J. M. Drummond,** A.S.A.A., F.I.M.T.A., a deputy chief accountant of the C.E.A., becomes chief financial officer, and **Mr. S. S. Scott,** M.A.(Oxon.), at present chief labour relations officer of the C.E.A., becomes chief personnel officer.

The General Electric Co. Ltd. announces the appointments of the following as assistant managing directors who will be responsible for individual groups : **Mr. T. W. Heather,** General Products Group (Production and Home Sales) ; **Mr. A. L. G. Lindley,** Engineering Group (Production and Sales, home and export), and **Mr. R. F. Robinson,** Telecommunications Group (Production and Sales (home and export). The appointments are also announced of the following directors : **Mr. D. G. W. Acworth,** who will be in charge of all overseas companies and export sales, and **Mr. W. J. Bird,** who will be responsible for home sales of the general products group.

* * *

Mr. C. P. McCallum, 18, Arnesby Avenue, Sale, Cheshire (Tel. No. : Sale 9509), has been appointed area manager of Alldays & Onions Ltd., Engineers, Small Heath, Birmingham, 11, as from January 1st, 1958. The area covered is Lancashire, Cheshire, Flintshire, Denbighshire, Caernarvonshire and Anglesey. Mr. McCallum has been connected with the fan industry for upwards of 30 years.

* * *

Mr. J. W. Plowman (Dewrance & Co. Ltd.) has been elected chairman of the British Valve Manufacturers' Association for the year 1957/58. The retiring chairman, Mr. N. P. Newman (Newman, Hender & Co. Ltd.) has been elected vice-chairman. The other members of the executive committee for the year 1957/58 are :—Mr. D. Bailey (Sir W. H. Bailey & Co. Ltd.) ; Mr. F. T. Bintcliffe (J. Blakeborough & Sons Ltd.) ; Mr. F. Burgess (Whites-Nunan Ltd.) ; Mr. C. F. Chambers (The Bryan Donkin Co. Ltd.) ; Mr. A. E. Dickinson [Smith Bros. & Co. (Hyson) Ltd.] ; Mr. D. S. Gardner (Glenfield & Kennedy Ltd.) ; Mr. H. L. Hammond (Crane Ltd.) ; Mr. K. M. Leach (Audley Engineering Co. Ltd.) ; Mr. A. L. Trump (Saunders Valve Co. Ltd.).

* * *

Mr. Iain Macleod, Minister of Labour and National Service, has appointed **Mr. T. W. McCullough,** O.B.E., to be H.M. Chief Inspector of Factories in succession to **Sir George Barnett,** who retired on December 31st, 1957. Mr. McCullough has been a deputy chief inspector since December, 1953.

* * *

Mr. Keith H. Ellson has been appointed home sales manager of the Balance Division of Geo. Salter & Co. Ltd., West Bromwich. He will be directly responsible to **Mr. I. H. Walter,** general sales manager. In the latter part of 1951 Mr. Ellson became sales representative, covering the Midlands area, and recently he has been senior balance representative for the Midlands.

James Hodgkinson (Salford) Limited have acquired a controlling interest in Bennis Combustion Limited and their subsidiaries—The Saxon Engineering Co. Ltd. and Bennis Mechanisations Ltd. Three Hodgkinson directors, **Mr. N. C. Crighton,** A.M.I.Mech.E., M.Inst.F., **Mr. E. L. Hollinshead** and **Mr. J. S. Hodge,** F.A.C.C.A., have been appointed to the board of Bennis Combustion Limited. The trading of these respective companies will continue under their own names as hitherto.

* * *

Metropolitan-Vickers Electrical Export Co. Ltd. has announced the appointment of **Mr. W. A. Hardman** as manager, Eastern Division.

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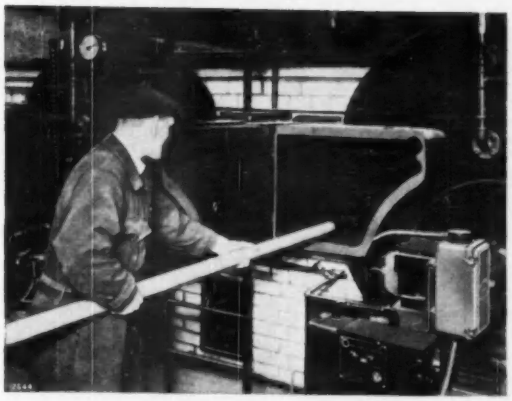
The organisers of the **Industrial Fuel Efficiency Exhibition,** which is being staged at Olympia from September 24th to October 3rd, 1958, announce that over 100 stands have already been booked, and the exhibits will embrace all phases of fuel efficiency. Approximately 90 per cent. of the available space has been taken, and intending exhibitors are advised to apply without delay, as remaining space is likely to be booked up very quickly. All enquiries should be sent to **Provincial Exhibitions Limited,** City Hall, Deansgate, Manchester, 3, who will be glad to forward a brochure which gives a preliminary list of the exhibitors, and other details.

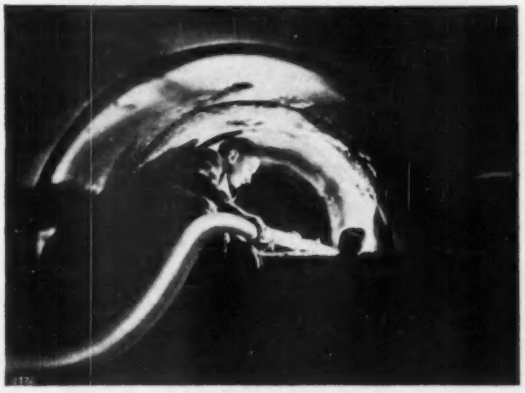
* * *

Elliott-Automation Limited announce that they have purchased the entire share capital of **Rotameter Manufacturing Co. Ltd.** in consideration of the allotment of 269,000 ordinary shares of 5s. each in Elliott-Automation Limited. Rotameter are leading manufacturers of variable-area flowmeters and density meters. Their products represent an important addition to the Elliott-Automation Group's range of instrumentation, and will further widen the scope of the Group's service to process industries. Rotameter will remain under the management under which it has grown to its present size, namely, Mr. H. R. Trost and Mr. A. H. Trost as joint managing directors and Mr. F. C. Whalen as technical director, and the business will continue to operate from the company's Croydon works.

* * *

We have received from **General Refractories Ltd.,** Genefex House, Sheffield, 10, a copy of their latest publication (No. 114 M.P.)—a leaflet which contains much useful information in the form of a chart for the rapid estimation of temperature gradients and heat losses through furnace walls ; and tables setting out the typical physical properties of "G.R." products, the temperature end points of pyrometric cones, and the approximate bending temperatures of Holdcrofts thermoscope bars.





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Sturtevant Industrial Vacuum Cleaners are extensively used for flue and boiler cleaning in stoker, P.F. and oil-fired boiler plants. Flue dust is extracted in large volumes simply and cleanly thus transforming this otherwise laborious and objectionable task into a cleaner and more effective operation.

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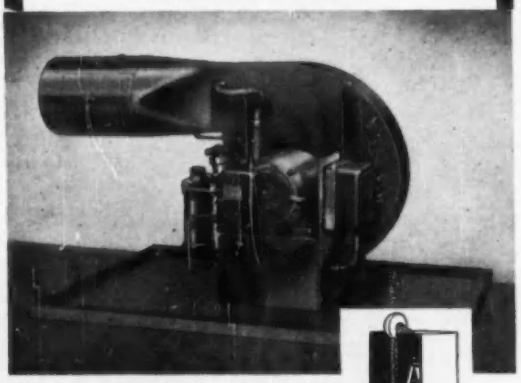
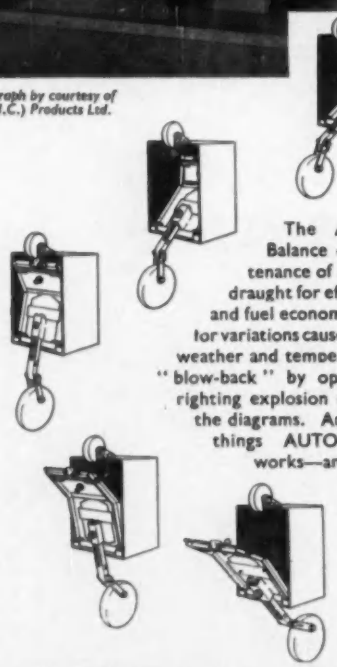


Photograph by courtesy of Riley (I.C.) Products Ltd.



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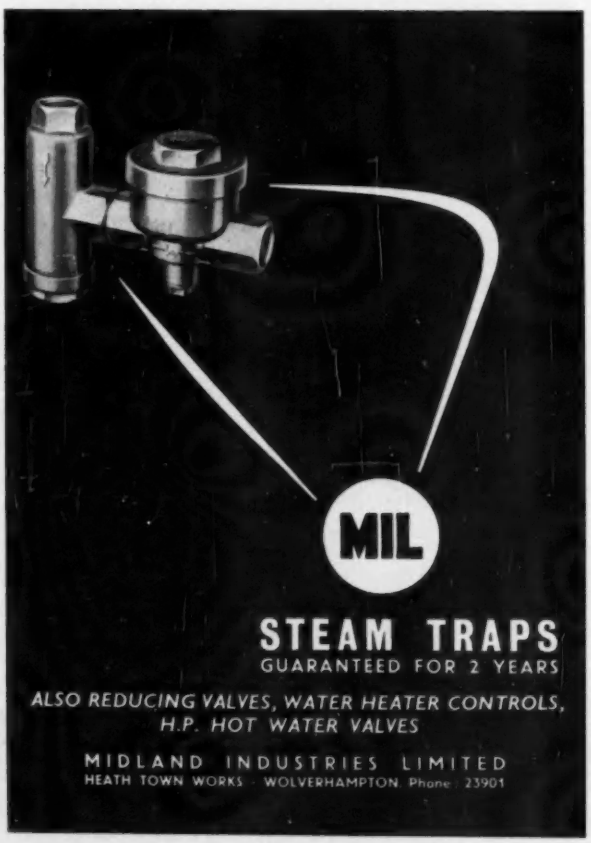

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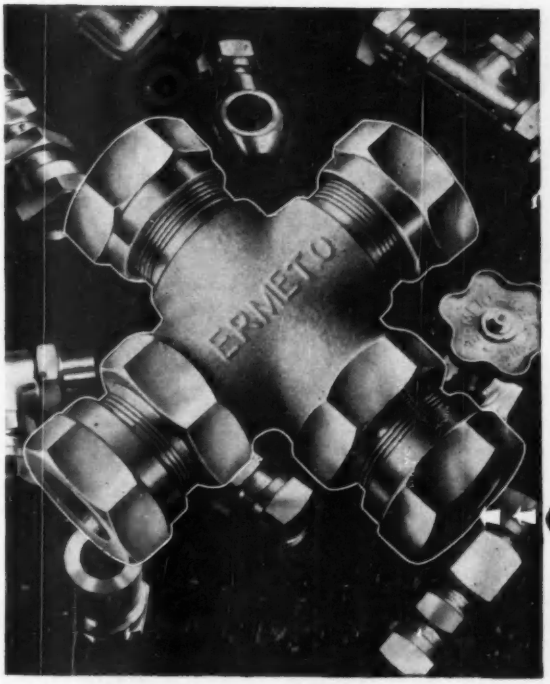

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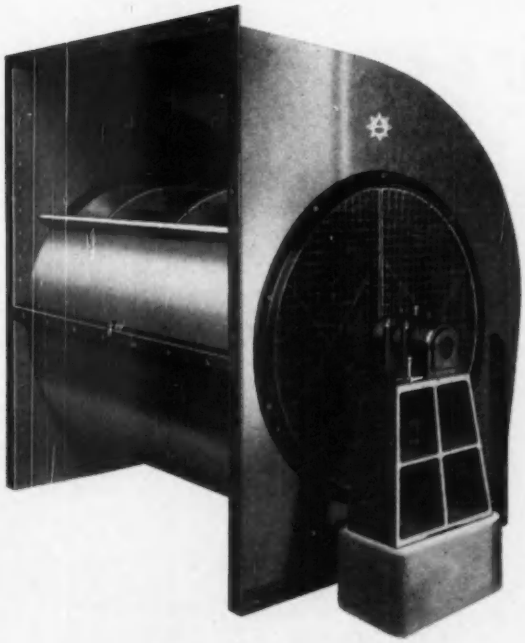

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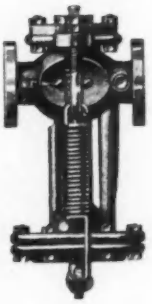

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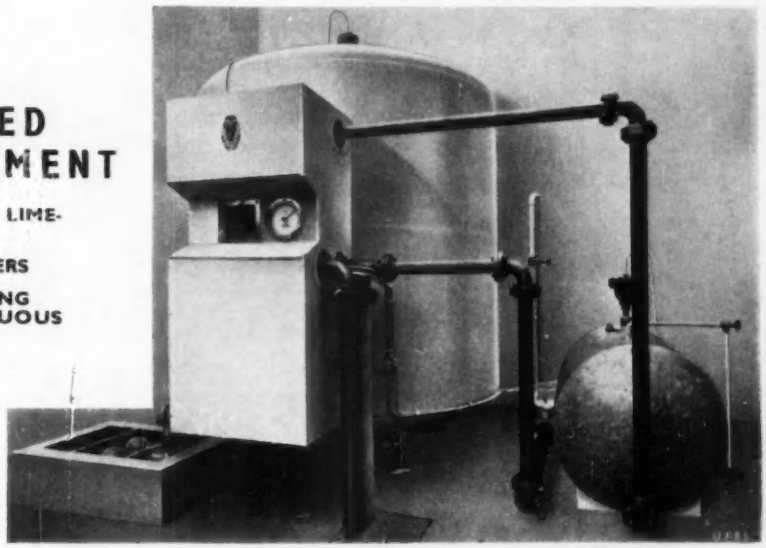

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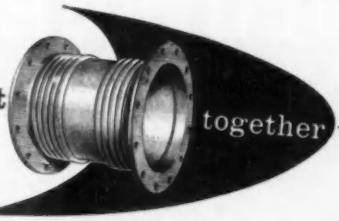
Let's get  together with . . .

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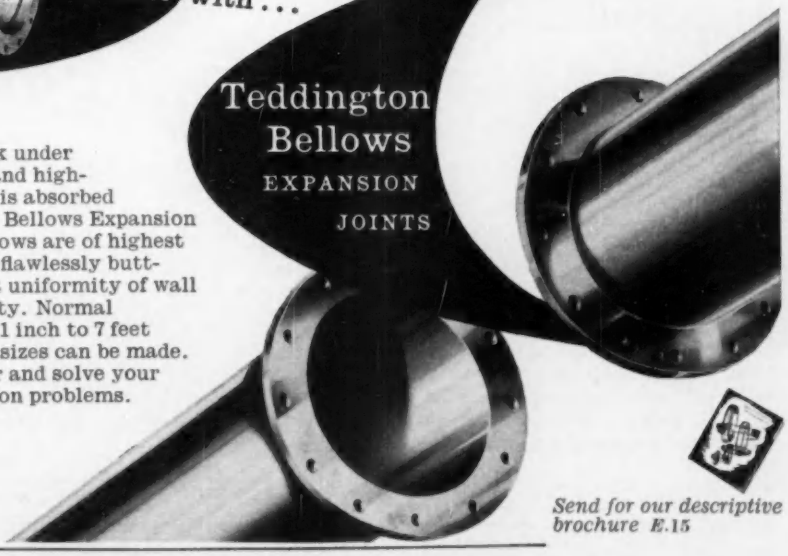

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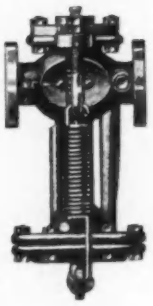

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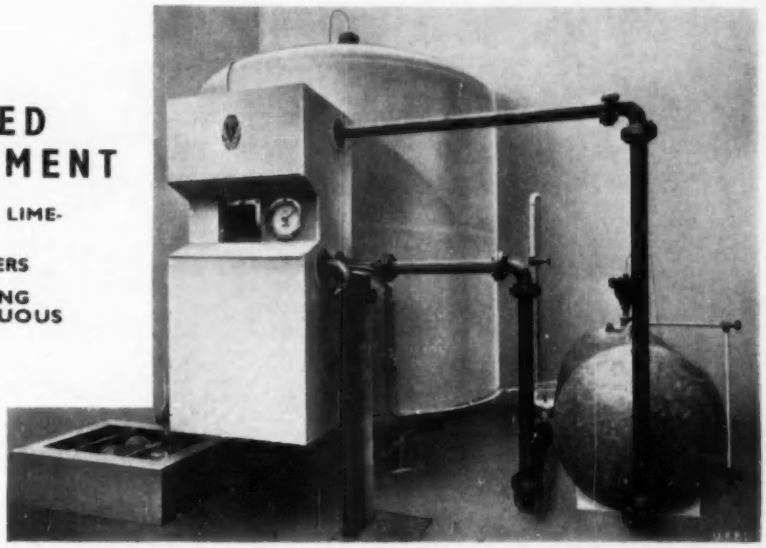

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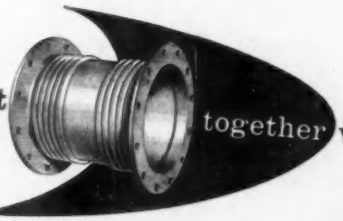
Let's get  together with . . .

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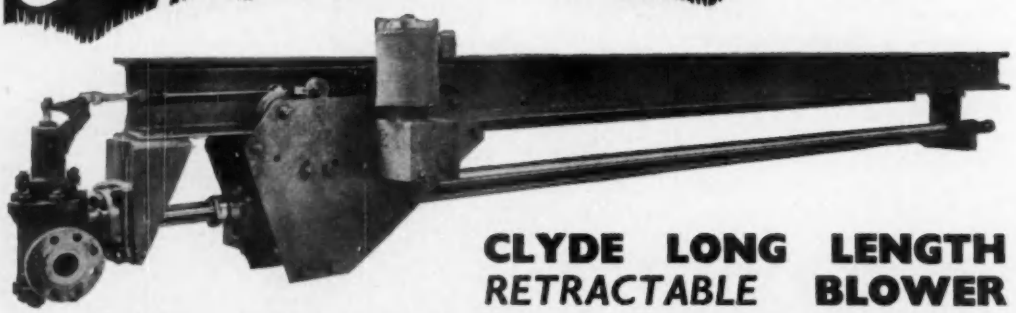

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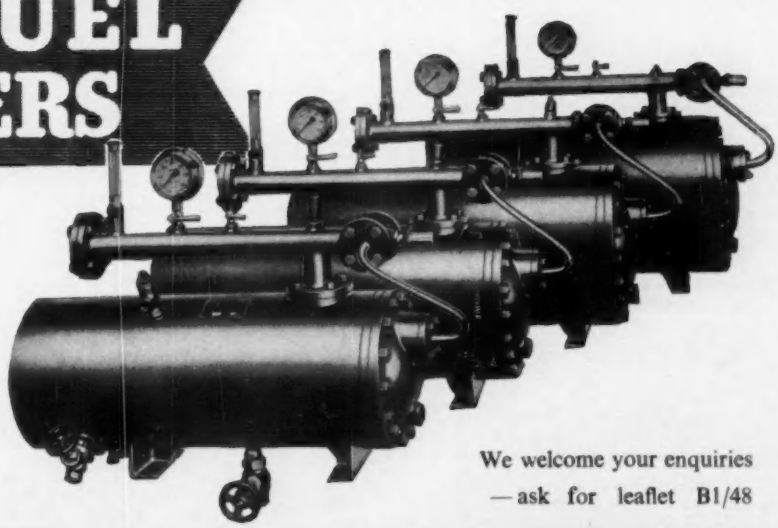

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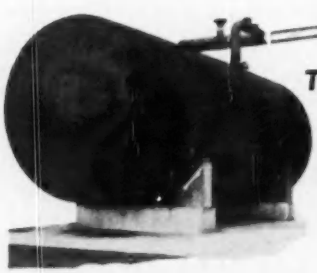

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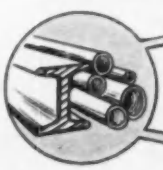

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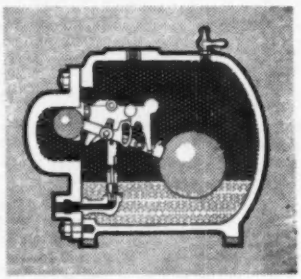

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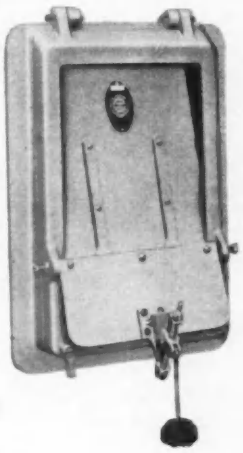

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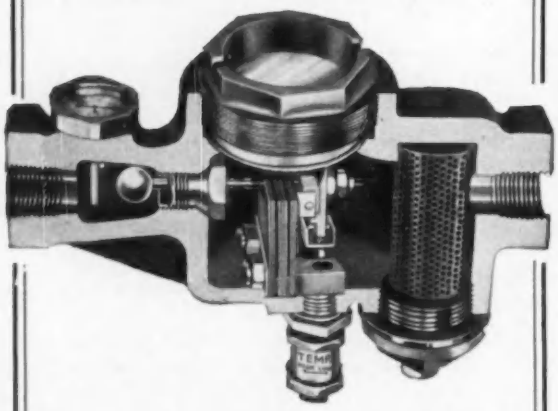

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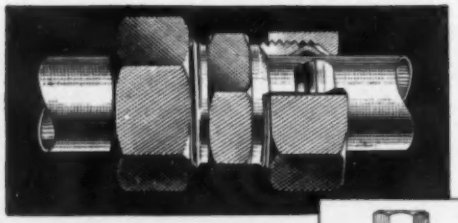
compression joints



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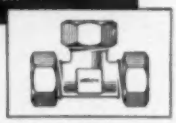

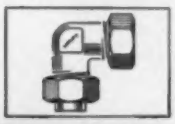

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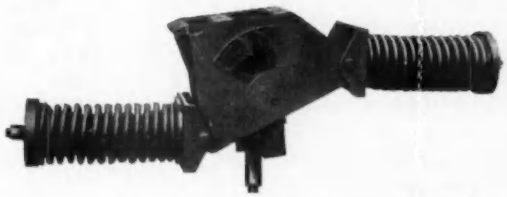

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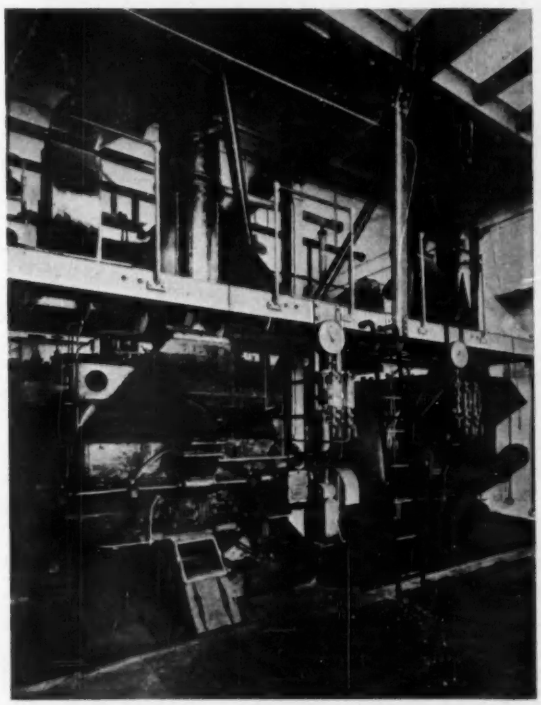

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—Master H. W. Pipe owns up

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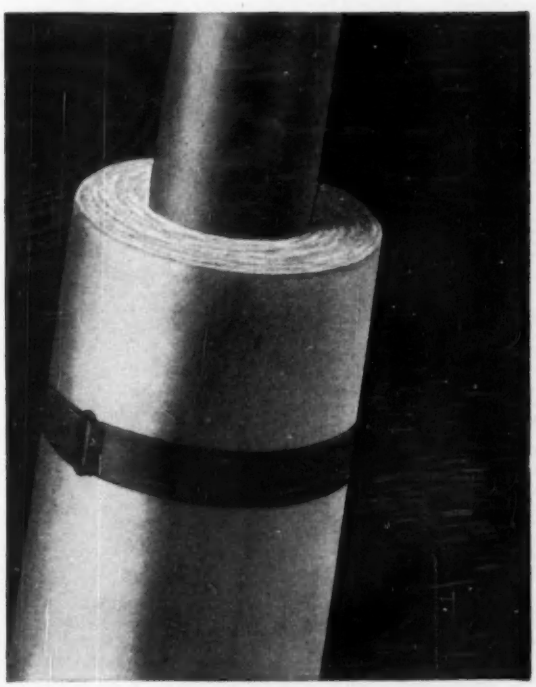

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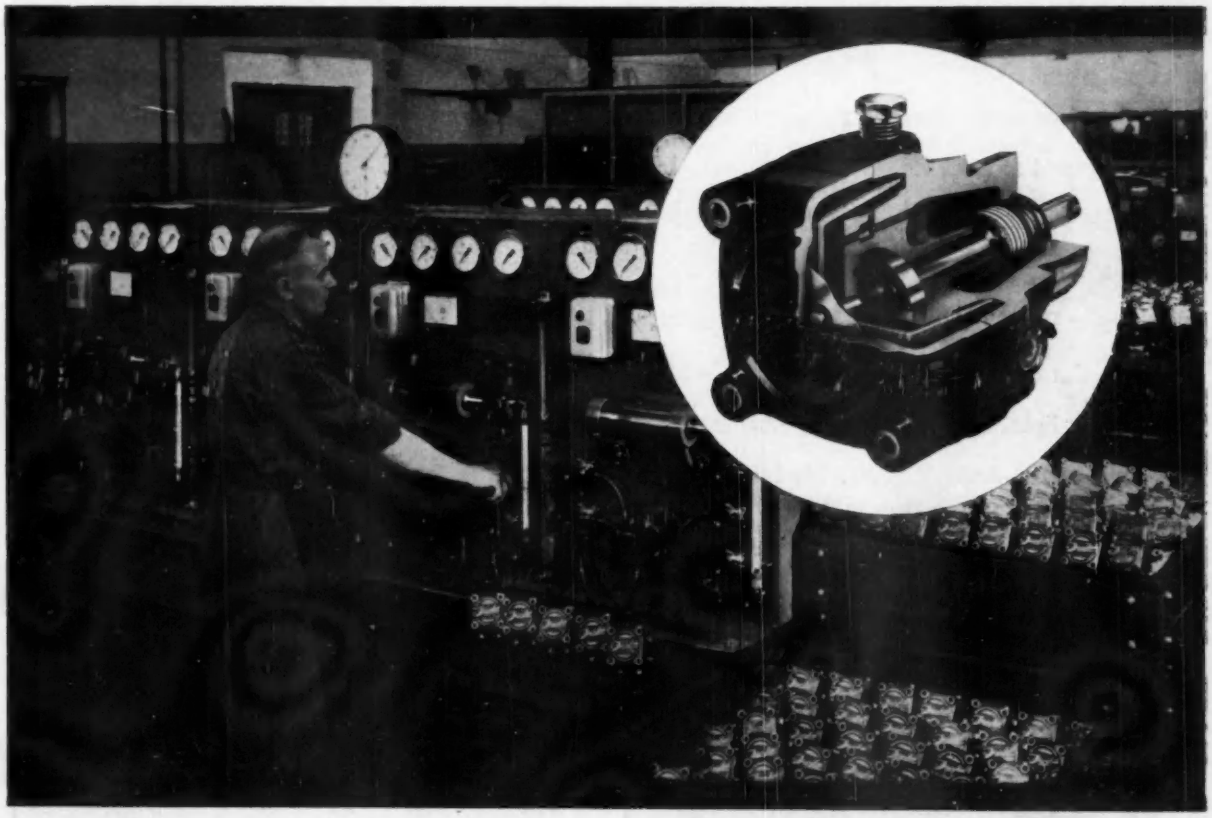

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Printed by Electrical Press Ltd., at Cordwallis Works, Maidenhead, Berks.
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